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Continuous brakes for long freight trains,

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Figs. 1 to 28, pp. 1290 to 1307.

(*Le Génie civil.*)

Official trials of brakes for long freight trains have been in hand since the Spring of 1921, as was pointed out by the Minister of Public Works on 7 December last in the Chamber of Deputies.

A Commission, under the presidency of the Director of Motive Power and Rolling Stock of the Government, has been appointed to carry out tests on the Westinghouse and Lipkowski compressed air brakes, and on the Clayton-Hardy vacuum brake.

A first series of tests commenced in March 1921, and were continued until July. These were as follows :

1° With the Westinghouse brake, on the Paris-Lyons-Mediterranean Railway, on the following lines :

Villeneuve-Saint-Georges to Montereau (gradient less than 1 in 250);

La Beaume to Die (line from Livron to Briançon) (maximum gradients 1 in 50);

La Freissinouse to Gap (on the same line) (maximum gradient 1 in 40);

La Chapelle-Laurent to Brioude (line from Brioude to Saint-Flour) (maximum gradient 1 in 30);

2° With the Lipkowski brake, on the line from :

Epone to Plaisir-Grignon (State Railway) (maximum gradient 1 in 91);

3° With the vacuum brake, on the line from :

Beauvais to Creil (Northern Railway) (maximum gradient 1 in 62.5).

A second series of tests, to which representatives of the Allied powers were invited, were commenced on 12 December and ended on 22 December. These tests, made with the three types of brake, were carried out on two portions of the Paris-Lyons-Mediterranean Railway :

1° The line from Villeneuve-Saint-Georges to Montereau;

2° The line from La Chapelle-Laurent to Brioude.

We hope to be able to give the results

obtained soon, but it may be interesting in the meantime to explain the general situation and the means by which the experts propose to solve the problem.

The pre-war situation. — It is nearly twenty years since the question arose in Europe of following the lead of the United States in applying to freight trains the automatic continuous brake, already universally used on passenger trains.

In 1909, the International Conference for the unification of railway technical practice, which met at Berne, drew up a programme of the conditions which must be satisfied by a brake which would be suitable for international traffic, and the various States represented at the Conference agreed to submit to the examination of an international commission the systems which they intended to adopt in their country. Austria in 1912 and Hungary in 1913 called together this Commission in order to submit to it, in the case of the former, the Clayton-Hardy vacuum brake, and in the latter case, the Westinghouse brake with two train pipes and provided with a new form of « triple valve ». The results of the trials were considered as being satisfactory by the Commission. Germany was to have put forward, in September 1914, another system of compressed air brake, the Kunze-Knorr, but the war prevented the Commission from meeting, and this brake was adopted by our enemies, without the approval of the Commission, and with the intention of enforcing its use after a victorious conclusion of the war. It was therefore necessary to include in the Treaty of Versailles a clause (1) requiring Germany to accept in international traffic the brake which might be adopted by the allies within a period of ten years after the conclusion of peace.

Meanwhile the problem was not entirely neglected in France. In 1910, the Orleans Company tested a very ingenious method of braking long trains. This method, which is due to the chief engineer, Mr. Sabouret, allowed the use of the existing pattern of Westinghouse brake by the simple expedient of inserting, at about the fifteenth vehicle of a train of 60 wagons, a special valve known as a « retarding valve » designed to automatically slow down the rate of propagation of the braking effect at the tail of the train, until the slack between the buffers is closed up, and the train may be considered as a continuous vehicle (1).

The results obtained by the Paris-Orleans were very satisfactory. The tests were repeated with less success on the Eastern, but under specially difficult conditions which would probably have been too difficult for any system of continuous brake.

The experiments with the so called continuous couplings, having been abandoned by the Eastern Company, were resumed in June and July 1914 by the Orleans Company, but the declaration of war intervened. Also, after the Paris-Lyons-

(1) Article 370 of the Peace Treaty runs thus :

« Germany undertakes to fit her own wagons so that it may be possible :

« 1° To include these in freight trains running on the lines of the allied and associated powers which were represented at the Berne Convention of 15 May 1886, as amended on 18 May 1907, without impairing the working of the continuous brake which may, within the ten years after the operation of the Treaty, be adopted in these countries ;

« 2° To accept wagons belonging to these powers in all freight trains on German railways.

« The rolling stock belonging to the allied and associated powers shall receive, upon German lines, the same treatment as German stock, as regards forwarding, attention and repairs. »

(1) *Le Génie Civil* published in its number for 15 July 1911 (Vol. LIX. No. 11) an article by Mr. Sabouret explaining in detail the principle and application of this method and the results of the original trials.

See also *Bulletin of the Railway Congress* for February 1912, p. 144.

Mediterranean trials had shown the advantages of a modified form of brake which avoided the special arrangements necessary with Mr. Sabouret's system, the companies which had not already, as in the case of the Orleans Railway, fitted a considerable portion of their rolling stock with the original brake, naturally preferred to fit the new brake.

On the other hand, the Paris-Lyons-Mediterranean Company had repeated, in 1912 and 1913, the trials made in Hungary with the Westinghouse brake, but in this case without the double train pipe, the disadvantages of which appeared to be more serious than that of requiring some brakesmen on the few sections of the line where long gradients of more than 1 in 50 are encountered. On the other hand the Lipkowski Company had just obtained permission to carry out trials on the State Railway of their improved brake for long trains, but these tests were interrupted, almost at their commencement, by the war.

The situation after the war. — During the war, the Germans informed the Entente powers, through Switzerland, of their decision to dispense with the approval of the International Conference as regards the adoption of a continuous brake for freight trains. This notification, together with applications made by the Lipkowski Company [1], in order to obtain a continuation of the tests which were interrupted by the war, resulted in the Minister of Public Works appointing a special commission, selected from the Technical Railway Committee, in order to choose a type of brake which might be proposed by France to Allies and neutrals, with a view to its adoption for international traffic.

The Commission chose the Clayton-Hardy vacuum brake because of the following advantages: extreme simplicity, low maintenance costs, simultaneous action and easy graduation.

The Minister therefore appointed a second commission to prepare a train fitted with the Clayton-Hardy brake, in order to demonstrate it to the Allies and neutral countries.

The work of this second commission and the preparation of the experimental train extended over two years, thus giving the supporters of the compressed air brake the opportunity of again putting forward the reasons, which they claimed to be decisive, which should lead to the adoption of the latter. The point was that the Technical Committee had agreed that the same brake ought to be used for both passenger and freight trains, and its decision in favour of the vacuum brake amounted to condemning the apparatus at present in service, both on the passenger and fast freight vehicles, and also on the slow freight wagons, a large number of which are already fitted with the compressed air brake.

Seeing that about 80 000 vehicles in all were concerned, the Minister of Public Works, while proceeding with the fitting of the Clayton-Hardy vacuum brake, also authorised the Paris-Lyons-Mediterranean Company and the Lipkowski Company to resume the experiments with the compressed air brakes.

It is these trials which are now being carried out, concurrently with the demonstration with the vacuum brake. They are being made in the presence of representatives from the allied powers.

Having regard to the importance of the decision which has to be made, on which will depend the expenditure of some hundreds of millions of francs, including the rigging and cost of fitting, we consider that it will be well, before dealing with the above tests, to review from a purely technical standpoint the exact position as regards the problem of braking long freight trains.

The existing systems. — The method which

[1] These applications were not made until after the decision of the Minister to fit a train with the vacuum brake.

is still used almost exclusively in Europe consists in the employment of brakesmen, who, in obedience to a code of whistles from the driver, operate, by means of hand wheels, the rigging which applies the blocks to the wheels. The American method on the other hand consists of fitting the freight trains with the Westinghouse compressed air brake, such as has been in use for a long time on passenger trains.

In this latter system, a compressor, carried on the locomotive, charges with compressed air a train pipe G (fig. 1) which runs the whole length of the train and from which are branch pipes to the distributors D, which are known as « triple valves ». By means of a handle, the driver can connect the train pipe G with the atmosphere, the pressure then falls all along the pipe, and the triple valves, by reason of this drop in pressure, act successively, thereby making a connection between the auxiliary reservoirs, one of which is carried on each vehicle and the brake cylinder, the piston of which operates the brake rigging.

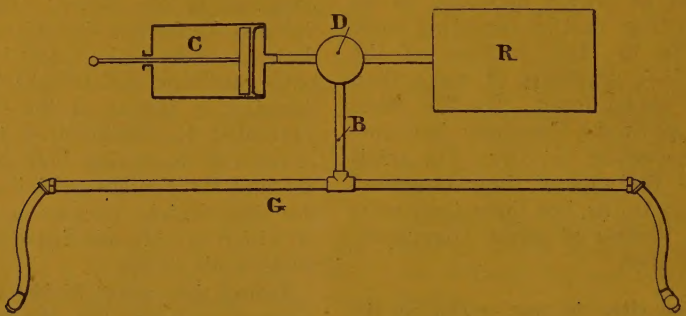


Fig. 1. — Diagram of Westinghouse equipment.

B, Branch pipe; — C, Brake cylinder; — D, Triple valve; — G, Train pipe; — R, Auxiliary reservoir.

The same effect is produced without any action on the part of the driver when the train pipe is broken through any cause whatsoever. The brake is thus automatic.

Figures 2 to 5, with the explanation attached, explain fully the construction and operation of the Westinghouse triple valve, which is very widely used in all countries.

It will be seen that the auxiliary reservoirs play the part of brakesmen and carry out their duties at the instant that the drop in pressure in the train pipe caused by the driver is felt by the triple valves. This drop in pressure is propagated along the train pipe at a maximum speed of 525 feet per second, less than half the speed at which sound travels. Thus there is an appreciable delay in applying the brakes at the rear of a long train. In the case of a train 3 281 feet in length, the air brake on the last vehicle does not begin to be applied till six seconds after the driver moves his brake valve, while the last hand brake can commence to be applied by a guard less than three seconds after the whistle is sounded.

On the other hand, the action of the compressed air is rapid and powerful, while that of the brakesman is applied gradually. It follows that with an air brake, the front vehicles are retarded sooner than the rear vehicles, and these tend to bunch up upon the front of the train, this action being accompanied by more or less violent shocks, whenever the force between the vehicles exceeds the strength of the buffer springs. For

the same reason, couplings may be broken by the rebound of the buffer springs when the brakes are released.

These effects are not serious in the case of American rolling stock, which is provided with automatic couplings capable of resisting a force of 136 t. (121 English tons), and which have the combined buffing and draw gear, designed to absorb the normal shocks which are produced in ordinary service stops. Any abnormal shocks, which cause the springs to be fully compressed, causes a friction device to come into action, and the force is dissipated by this frictional action, instead of being stored in the spring. When the latter again extends, it returns the friction device to its initial position, thus the effect of the rebound of the spring is not greater than in the case of normal shocks.

Under these conditions, the compressed air brake is used with success on long freight trains in America, in spite of its harsh and non-simultaneous action.

Having made these general observations, we will now proceed to describe the rival systems of brakes which are used at present in Europe. These are the Westinghouse, Kunze-Knorr and Lipkowski, all of which are air brakes, and the Clayton-Hardy vacuum brake.

Compressed air brakes.

Westinghouse brake — The *Westinghouse triple valve* in its simplest form consists of the following essential parts (fig. 2):

A cast iron body contains a piston P, the two sides of which are subjected to the pressure of the train pipe and auxiliary reservoir respectively. By making a reduction in the train pipe pressure, the driver causes piston P to move, and its spindle T carries:

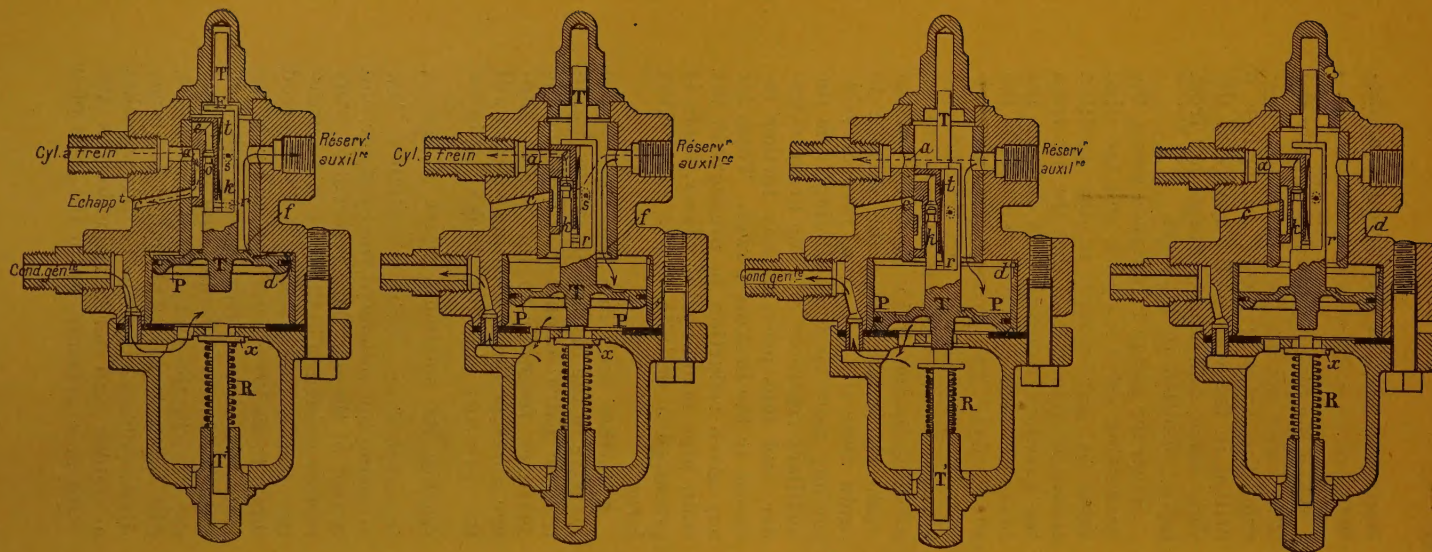
1° By means of a pin *r*, a small valve *k*, known as the graduating valve;

2° A slide valve *t*, which has a certain amount of play in the direction of motion.

When the piston and consequently the slide valve are in the uppermost position, the valve *k* closes an orifice *o* drilled in the wall of the cavity of the slide valve, and thus prevents air from being admitted to the port.

When the piston P is forced down, the graduating valve *k* opens, and the slide valve is also moved to the position shown in figure 3, so that the air from the auxiliary reservoir can flow to the brake cylinder by way of the port in the slide valve. The pressure in the auxiliary reservoir is thereby reduced, and when it becomes less than the pressure existing in the train pipe, the piston again rises and causes the valve *k* to again close the orifice *o*, thus preventing any more air from feeding from the auxiliary reservoir into the brake cylinder, and thus prevents any further increase in the braking power. Thus, for any given reduction in pressure in the train pipe made by the driver, there is produced a definite degree of braking force.

A further reduction will produce an increase in the braking power by admitting an extra amount of air from the auxiliary reservoir to the brake cylinder, through the graduating valve, until the pressure in the brake cylinder reaches its maximum valve of $\frac{C}{R + C}$ in accordance with Mariotte's law (C being the volume of the cylinder, and R that of the auxiliary reservoir). Any further reduction in the train pipe pressure causes the piston P to be forced down to its lowest position and puts the reservoir into direct communication with the brake cylinder (not by way of the port in the slide valve) (see fig. 4, full application). This effect is immediately obtained when the driver makes a sudden and large reduction in the train pipe pressure, or in the case of a



Figs. 2 to 5. — Sectional views of the Westinghouse triple valve in its various positions.

Explanation of the French terms : Cyl. à frein = Brake cylinder. — Echapp^t = Exhaust. — Cond. gén^le = Train pipe. — Réser. auxil. = Auxiliary reservoir.

Fig. 2. — *Brake « off » position.* — Normal working pressure is maintained in the train pipe, and piston P and slide valve *t* are in their uppermost position. The port *a* leading to the brake cylinder and the exhaust port *c* are put into communication by the cavity of the slide valve. Compressed air from the train pipe feed into the auxiliary reservoir through the feed groove *d*, cut in the upper end of the cylinder in which the piston P moves.

Fig. 3. — *Partial application.* — When the driver reduces the pressure in the train pipe, the piston P is forced downwards. The slide valve does not immediately move owing to there being a certain amount of play, but the graduating valve *k*, which is operated by pin *r*, is withdrawn from its seat. Further movement of the piston moves down the slide valve so that port *o* in the slide valve corresponds with port *a* in the valve face, and compressed air passes to the brake cylinder. The piston does not travel to the full length of its course unless the pressure on its upper face is greater than the pressure in the train pipe together with the force exerted by the spring R on the head of the plunger T', as this plunger tends to prevent the tail piece of the piston from descending to the end of its course.

Fig. 4. — ***Full application.*** — The reduction of pressure in the train pipe is sufficient to force piston P to the lower end of its course. The slide valve is drawn down so that port *a* is uncovered, thus giving a free access to the brake cylinder.

Fig. 5. — *Position of equilibrium in a partial application.* — When the pressures on the two sides have equalised and the pressure in the auxiliary reservoir, continuing to fall, becomes slightly less than the pressure in the train pipe, the piston P again rises sufficiently to close the graduating valve *k* which is operated by the pin *r*. The degree of application is thus dependent upon the extent of the reduction in pressure in the train pipe made by the driver. A further reduction again causes the piston to move down and admit more air to the brake cylinder. This process can be repeated until the pressure remaining in the train pipe is equal to the pressure remaining in the auxiliary reservoir, this giving the maximum pressure obtainable in the brake cylinder.

break away. It will be seen that the brake can be graduated when making an application.

To release the brakes, the driver increases the pressure in the train pipe, which has the effect of immediately forcing the piston P to its uppermost position, and connects the brake cylinder to the atmosphere through the exhaust port (fig. 2), thus the release cannot be graduated. The release is very rapid, and when in the release position the auxiliary reservoir is recharged through the feed grooves *d* and *f*.

A graduated release is not impossible in an air brake, and a number of devices have been suggested, in the United States and elsewhere, for realising this feature. However, in the United States, which is the only country which makes a practice of applying continuous brakes to all freight trains, little importance is attached to this feature, and it is not thought to warrant the extra complication as compared with the present system.

In order to guard against a full application of the brakes being unintentionally produced by a slight reduction in pressure or leakage from the train pipe, the spindle of the piston T is prolonged below the piston by a tail piece, which before an emergency application can be made, must overcome the resistance of the spring R (figs. 2, 3 and 4).

In Europe, where the couplings are comparatively slack, and where the draw gear is not as a rule capable of resisting a force greater than 33 t., it is only since the Westinghouse Company decided to make this brake more responsive and less harsh in its action, that any tests with the air brake on heavy trains have been attempted. It has been made more responsive by *accelerating* the discharge of air from the train pipe, thus reducing the interval between the functioning of successive triple valves. It has been made less harsh by *reducing* the size of the orifice through which the air passes in flowing from the auxiliary reservoir to the brake cylinder, so as to increase the length of time necessary to fill the latter.

The role of the *accelerators* is to repeat by a serial action along the train, the reduction of pressure in the train pipe made by the driver. When these operate, they connect the train pipe to bulbs in which there is normally atmospheric pressure. By their use, the speed of propagation is increased to 525 feet per second. At the same time the period necessary to fill the brake cylinders has been increased to about 36 seconds. It follows that the brake on the first wagon is not fully applied till after about 36 seconds, by which time the last brake is applied with five-sixths of its maximum force.

However, when applying the brake it is necessary to take up the slack in the rigging and to bring the blocks on to the wheels quickly. It is desirable therefore from this point of view not to restrict the orifice between the auxiliary reservoir and the brake cylinder till after an appreciable time has elapsed after the commencement of the application.

The improved Westinghouse triple valve for long freight trains (figs. 6 to 8) fulfils all these conditions. With this apparatus the brake retains all the characteristics of a hand brake, without loosing the invaluable property of being automatic, and is thus independent of the human factor. This triple valve works in exactly the same way as the ordinary triple valve as regards the feeding of the auxiliary reservoir and the release of the brake.

As regards the application of the brake, it has the following features :

« 1° *The pressure in the brake cylinder is built up in two phases :*

« *First phase.* — The triple valve gives a rapid initial admission of air into the cylinder, so as to bring the brake blocks

on to the wheels as quickly as possible and to place all the vehicles of the train in a position favourable for a brake application.

« *Second phase.*—When the pressure in the brake cylinder has reached 14.22 lb. per square inch, the flow of air is checked so that the braking power is increased slowly, so as to reduce the surging effect between the vehicles. This admission of air in two phases is produced in the following manner (see fig. 6). As long as the pressure in the brake cylinder in less than 8.533 lb. per square inch, the valve *c* is held off its seat by the spring *r*, and the air passes to the cylinder through passages *w* and *x*, but when the pressure in the cylinder exceeds 8.533 lb. per square inch the piston *p* is forced down and valve *c* closes on to its seat, and the flow of air to the cylinder can only take place through the orifice *w*.

« 2° *An accelerated propagation of braking effort is obtained for service applications as well as for emergency applications.*

« This feature is obtained (figs. 7 and 8) by means of a bulb A, which the slide valve puts into communication with the train pipe for both service and emergency applications, and exhausts to the atmosphere when the brake is released. »

This triple valve has been tried both on the Hungarian State Railways and the Paris-Lyons-Mediterranean, and has given excellent results. It has been proved that goods trains which are thus fitted can be stopped without shock or breakage of the couplings in a shorter distance than the same trains would require with hand brakes. It should be noted that the insertion of a number of wagons not braked, but merely piped, between two braked wagons has no objectional effect.

It is thus possible to insert vehicles fitted with the passenger stock type of brake in a goods train, provided that the brakes are cut out on these vehicles, by shutting a cock so as to close the communication between the triple valve and the train pipe. On the other hand, if it is not considered desirable to isolate the brake on the coaching stock vehicles, the solution is to replace the triple valves in use at the present time by special triple valves, so that the communication between the auxiliary reservoir and the brake cylinder can be made through a large or by a restricted orifice, as required. The construction of a device of this kind presents no difficulty, if experience proves that there is sufficient advantage to be gained.

Control of speed on gradients : The case of long and steep inclines. — The problem would thus be completely solved were it not for the difficulty created by the descent of long and steep inclines, which we have not mentioned as yet. In order to maintain a constant speed, one should in fact keep the brake blocks applied to the wheels during the whole time that the descent is being made, and taking as an example the lines through the Alps, this may take as much as an hour or more [1]. During such a long

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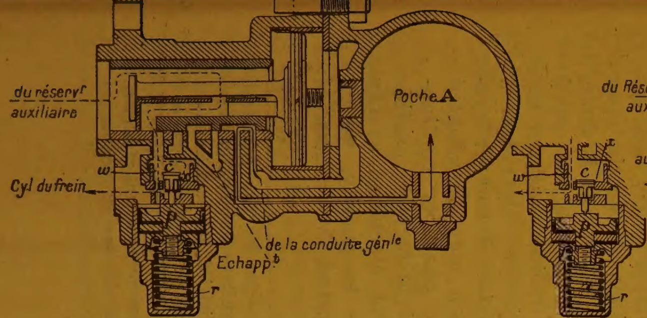
[1] It should be noted, however, that in Europe, and especially in France, the control of speed on long and steep inclines is not so important a factor as it is in the United States.

The American railroads are daily handling coal and mineral trains of 4 000 t., which descend from the mines which are situated in the mountains down long and steep inclines, with only one locomotive. « Retarding valves » are used in these cases. On the other hand, on undulating lines or on long gradients where there is an equal amount of traffic in either direction (as is generally the case in this country), engines which are capable of hauling the trains up the inclines are fully capable of holding them back when descending; having in the first case to overcome gravity plus the resistance of the train ; and in the second case to resist the same gravity componed minus the same resistance. In either case the capacity of the locomotive is limited by its adhesion.



First phase of application. Second phase of application.

Fig. 6. — Service application.

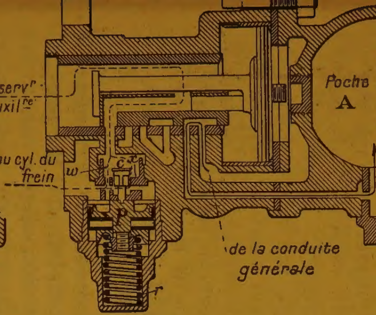


Fig. 7. — Emergency application.

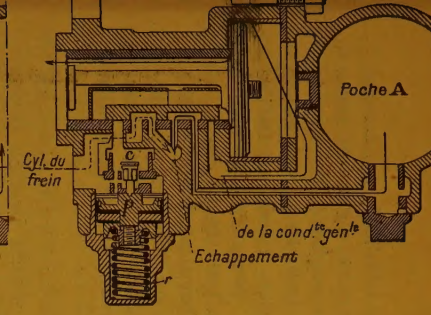
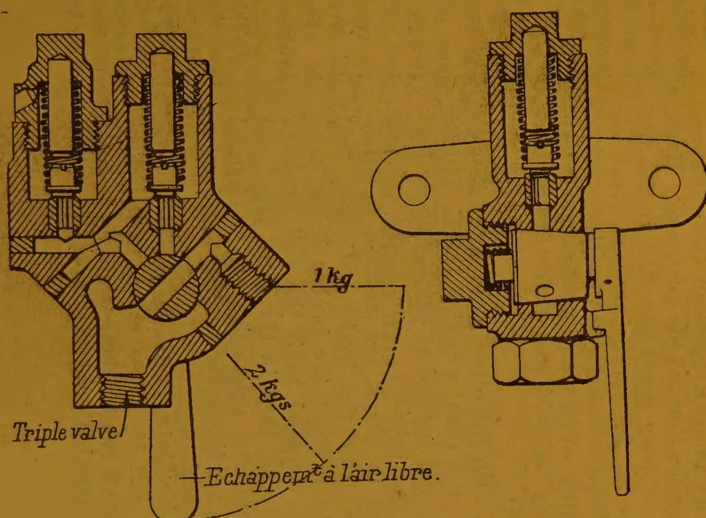
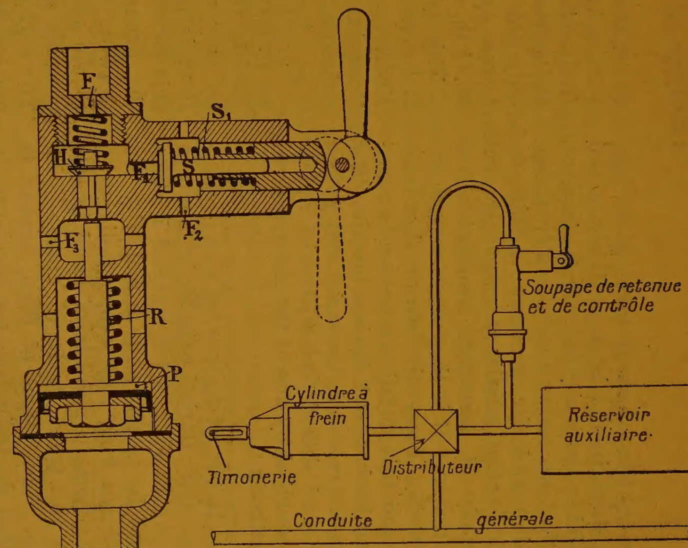


Fig. 8. — Release.

Figs. 6 to 8. — Section of special Westinghouse triple valve for freight trains, in different positions.



Figs. 9 and 10. — Sections of Westinghouse retaining-valve.



Figs. 11 and 12. — Diagram of arrangement and section of Seguin's double retaining and control valve.

Explanation of French terms of figures 6 to 12 : du réserv. auxiliaire = from auxiliary reservoir. — Poche A = Bulb A. — Au cyl. du frein = to brake cylinder. — Echappement = exhaust. — De la conduite générale = train pipe. — Soupape de retenue et de contrôle = Retaining and control valve. — Distributeur = Triple valve. — Réservoir auxiliaire = Auxiliary reservoir. — Cylindre à frein = Brake cylinder. — Timonerie = Rigging. — Conduite générale = Train pipe.

period of time, leakage takes place past the pistons in the brake cylinders, and the brakes gradually release themselves. It is then necessary to make a fresh application and the pressure is thus reduced in the auxiliary reservoirs till eventually it becomes insufficient to make a stop. It is then necessary to recharge the reservoirs from the train pipe, and this entails completely releasing the brakes, but during the time the brakes are released, the train will gather speed, and this defect will exist unless it is remedied by one of the three following methods :

A. — In the first place, as was proposed by the Paris-Lyons-Mediterranean Company in 1912, a few special brakesmen can be employed to travel with the train down long and steep gradients to apply a certain number of hand brakes before the train starts to descend the incline. The effect of these brakes is such that the train does not accelerate to a dangerous amount during the relatively short interval between two consecutive applications of the air brake. However, on long gradients of 1 in 33, the variations in speed are as great as 12 miles per hour, and this gives rise to a feeling of insecurity, though it can scarcely be said that there is any real danger.

B. — On the other hand, one can also follow the usual practice in the United States, and instead of employing brakesmen, use retaining valves, these being devices to check the exhaust to atmosphere from the brake cylinders, and thus to prevent the brakes being completely released until the full pressure is again attained in the train pipe, and the auxiliary reservoirs are re-charged and in readiness for another application of the brakes.

The retaining valve is shewn in figures 9 and 10. Two valves of the same area are held on their seats by springs which are both set to allow the valves to lift at a pressure of 14.22 lb. per square inch. A three-way cock allows either a free exhaust to atmosphere, or causes the exhaust to pass both these valves, or only one of them, thus retaining in the brake cylinder a pressure of either 28.44 lb. or 14.22 lb. per square inch.

This system has been used during the last series of trials on the Paris-Lyons-Mediterranean (March 1921). The variations in the speed did not exceed 6.25 miles per hour.

C. — Finally, a second train pipe can be provided, from which branch pipes lead to the brake cylinders, though not by way of any triple valves. This method is used in Hungary. When using this second train pipe, the driver applies the brake in a direct manner, without drawing on the compressed air stored in the auxiliary reservoir, which always remains as a reserve of braking power. The variation in speed in this case does not exceed 3 miles per hour.

Of these three methods, the last mentioned is the most complete, but the progress of electric traction allows one to hope that in the comparatively near future the mountain lines will for the most part be electrified. When this is done, it will be possible to control the speed on long and steep inclines without the use of brakes, which are only required for stopping the train. Whatever system of electrification may be adopted (single phase, three phase or continuous current) it will in fact be possible to recover as useful electrical energy all the energy due to gravity, which is otherwise dissipated by means of brakes [1].

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[1] This is already the case on two American lines, the Italian electrified lines through the Mont-Cenis, and in the Genoa district, and on one mineral railway in the South of Spain. It may be claimed that every line in Europe where the weight of the trains necessitates speed control by means of brakes, will be electrified before the use of continuous brakes becomes general.

Under these conditions, the Westinghouse brake, as recommended by the Paris-Lyons-Mediterranean Company in 1913, is a solution of the problem, which would be still more acceptable if there were no further need for employing special brakesmen on the inclines.

As we have already stated, during the 1921 tests on the Paris-Lyons-Mediterranean, *retaining valves* were used in accordance with American practice. This system necessitates that the valves should be « cut in » before descending long and steep inclines, and « cut out » after arriving at the foot of the incline. This is a serious inconvenience, since this entails the opening or closing by hand of a cock on each of the vehicles fitted with these valves (1).

To overcome this disadvantage, the Lipkowski Company advocates the use of a *double valve* known as a « *retaining and control valve* » which has recently been patented by Mr. Etienne Seguin.

This device (figs. 11 and 12) is connected both to the exhaust from the triple valve, and to the auxiliary reservoir. As long as the pressure in this reservoir is less than the minimum necessary to make a satisfactory stop, a spring R holds the piston P *in its lowest position*, and the valve H, which is controlled by the spindle of this piston is then *closed*, so that the exhaust from the brake cylinder, which enters through the pipe connection F cannot escape to the atmosphere (through the orifices F_2) until the piston S has compressed the spring S_1. Thus, the exhaust from the brake cylinder cannot continue after the pressure in the braked cylinder has become too small to overcome the resistance of the spring S_1, and it is easy to regulate the setting of this spring. However, as the recharging of the auxiliary reservoir commences at the same instant as the exhaust commences, after a short time there is sufficient pressure in the reservoir to insure a satisfactory stop, and the piston P then rises, *opening* the valve H, and thus producing a complete release of air from the braked cylinder, through the pipe connection F_1, and orifices F_3.

The use of this valve thus insures safety, not only on long and steep inclines, but throughout the entire run, since after each application of the brake, it will be impossible to start away without the pressure in the auxiliary reservoirs being sufficient to make a satisfactory stop. It remains to be proved how this new valve will behave under everyday working conditions.

Testing brakes. — The difficulty which is experienced with long trains in making the test of the brakes which should be carried out before starting away, and after every occasion on which vehicles are attached or detached en route, has also been overcome by the use of a tail valve known as the « *Omega* » valve, which allows this test to be made from the engine. The driver can thus satisfy himself that the train pipe is properly connected up throughout the entire length of the train, though this does not obviate the need for inspecting the brakes to verify that they are working satisfactorily and that the brake blocks are properly adjusted to the wheels.

Kunze-Knorr brake. — This brake is not one of those at present under trial in

(1) It may be claimed that this inconvenience is not of very great importance as far as France is concerned, the sections of line to which it would apply being few in number. From the point of view of economy, the scheme proposed by the Paris-Lyons-Mediterranean Company this year appears to be very interesting. The *retaining valves* are to be detachable, and by means of a connection on the train pipe on the wagons can be attached in a few moments at the top of the incline, and removed at the foot of the incline. In this way a very small stock of valves is required, and these can easily be kept in repair. Also, as these valves are used on one particular portion of the line, they can be set to be suitable for the particular circumstances.

France, and would not be mentioned here but for the fact that it is to some extent a little known rival to the Westinghouse, Lipkowski and Clayton-Hardy systems. As we have already stated at the beginning of this article, the Prussian railways, before the war, carried out trials with the Knorr system (which later became the Kunze-Knorr), which led to the adoption of this system in Germany during the war. It is certain that Germany's object was to extend its use in the countries of Central Europe before the definite decision of the Powers and of the International Berne Commission might be given in favour of some other system, the adoption of which would then be hampered by serious technical and financial difficulties.

We therefore think that it will be of interest to describe here the principles of the Kunze-Knorr brake, without entering into details, which will be found in a special article published in the *Génie Civil* (1).

This brake largely resembles the 1901 type of Lipkowski brake (2), from which it has borrowed the arrangement in tandem of the two already known and separately used systems of braking passenger trains, namely, a « *one* chamber » brake and a « *two* chamber » brake, operating successively upon the brake blocks.

Thus, in the Westinghouse, which is a « *one* chamber », one side of the piston in the brake cylinder is always under atmospheric pressure, while the other side is connected alternately with the auxiliary reservoir or with the atmosphere. Thus it is the difference between the pressure exerted on one side of the piston and the pressure of the *atmosphere* which moves the piston and determines the strength of the application.

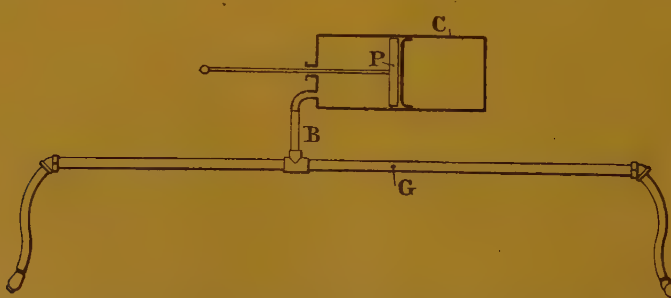


Fig. 13. — Diagram of arrangement of a two chamber compressed air brake.

B, Branch pipe; — C, Brake cylinder; — G, Train pipe; — P, Piston.

On the other hand, in the case of the Wenger, Karpenter, etc., and similar brakes (see fig. 13) the two sides of the piston are normally subjected to the same pressure as exists in the train pipe. A reduction in the pressure in the train pipe produces the same reduction in one of the chambers, and the piston moves and applies the brakes with a force proportional to this reduction in pressure. The quantity of compressed air enclosed in the other chamber of the brake cylinder remains the same, but its pressure varies with the displacement of the piston. This compressed air acts as a *spring* and forces the piston towards the end of the cylinder when a reduction in

(1) See *Génie Civil* for 29 May 1920, No. 22, Vol. LXXVI.

(2) See the description of this brake in the *Génie Civil* for 5 December 1903, No. 5, Vol. XLIV.

pressure is made in the other chamber. The brakes are thus applied. When the pressure is again restored in the train pipe which is connected with the first mentioned chamber, an equal pressure is again produced on the two sides of the piston, and the brakes are released. A *two* chamber brake, such as this, can naturally be fully graduated, both when applying and releasing, but its action is less rapid than that of a one chamber brake.

In the *Kunze - Knorr* arrangement, known as the « Combined compound », the piston rod of the brake cylinder F with two chambers A and B is co-axial with the piston rod of brake cylinder F′ with one chamber C. Each of these pistons are connected independently to the brake rigging. In the running position the *triple valve* puts the two chamber brake cylinder F into communication with the train pipe, and the one chamber cylinder F′ is open to the atmosphere (fig. 14).

When a reduction of pressure is made in the train pipe, the triple valve cuts off the communication of chamber C of cylinder F′ with the atmosphere, and puts this cylinder into communication with the train pipe, the air which is discharged from the same causing a slight application of the brakes. When this pressure reaches a certain amount, a valve cuts off the communication with the train pipe and connects chamber C with chamber B of the two chamber brake cylinder F. The pressure then decreases in chamber B and increases in chamber C, the piston of the two chamber brake also coming into action (fig.15), in consequence of the pressure of air in chamber A until the pressures in chambers B and C, which are still in communication, and in chamber A are equalised. Piston S then comes to rest, its position corresponding to a definite pressure exerted upon the brake blocks by piston C.

If the driver makes a further reduction of pressure in the train pipe, the same cycle of operations is repeated, and the pressure on the brake blocks is increased.

On the other hand, if the driver increases the pressure in the train pipe, the pressure on the brake blocks is decreased.

A brake on the above lines operates with the rapidity of a Westinghouse brake, but has all the moderability of a two chamber brake. It would appear suitable for use upon long gradients without the necessity for using the second train pipe, for the brakes are applied without taking any air from chamber A of the two chamber cylinder, which takes the place of the auxiliary reservoir. However, it is to be feared that there will be leakage from this chamber past the packing of the small piston S, and it is scarcely likely that this effect will not be experienced on long and steep inclines, with the equipment in the imperfect condition that can hardly be avoided on goods wagons.

It is also possible to vary the brake power at will, according to whether the wagon is empty or loaded. For this purpose a valve (figs. 17 and 18) is interposed in the air passage between B and C. The valve closes this passage as soon as the pressure in chamber C reaches its maximum, and at the same time opens a port which allows the air remaining in chamber B to escape to the atmosphere. Piston S can then continue its stroke after piston C has come to rest. By means of the slotted crosshead on the end of its rod, piston S then acts on the rigging to increase the braking force. By closing a special cock, the air may be prevented from escaping from chamber B to the atmosphere, and consequently this additional braking force does not come into play.

As we have already stated, the principle on which the Kunze-Knorr brakes

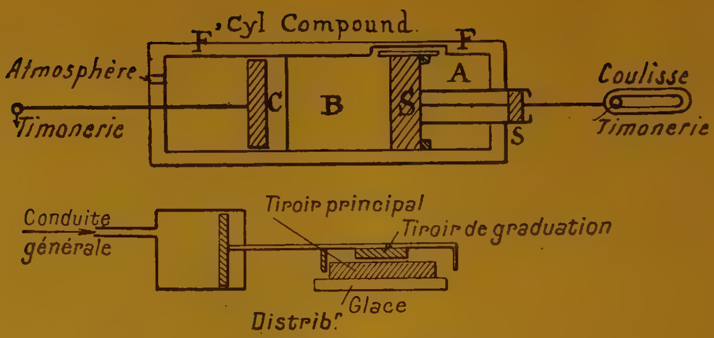


Fig. 14. — Brakes off position.

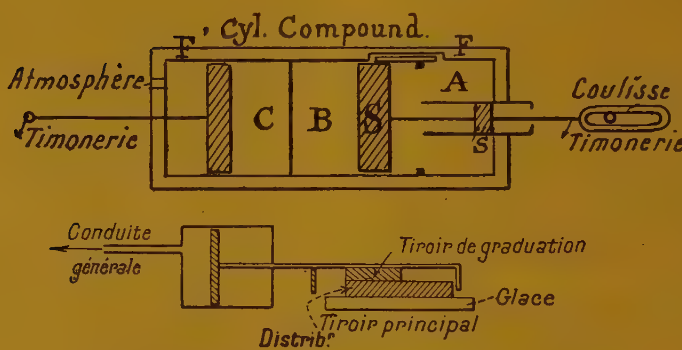


Fig. 15. — Position at commencement of brake application.

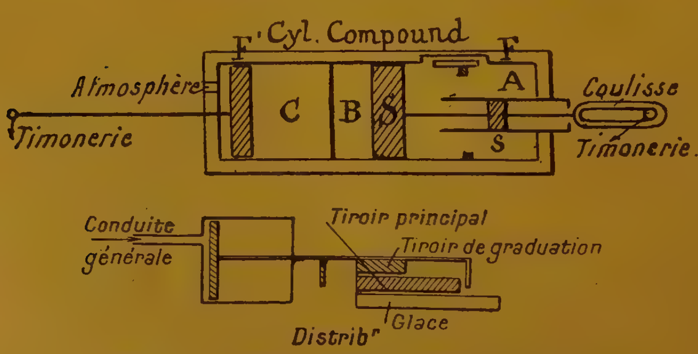


Fig. 16. — Position during a partial application.

Figs. 14 to 16. — Diagrammatic sections of Kunze-Knorr compressed air brake.

Explanation of French terms: Cyl. Compound = Compound Cylinder. — Atmosphère = Atmosphere. — Timonerie = Rigging. — Coulisse = Slotted cross-head. — Conduite générale = Train pipe. — Tiroir principal = Main valve. — Tiroir de graduation = Graduating valve. — Glace = Valve face. — Distribr = Triple valve.

work is identical with that of the 1901 type of Lipkowski brake. In the latter, however, there is no risk of leakage past the piston rod packing, as this does not pass through the chamber which forms the auxiliary reservoir of the two chamber brake.

It is only the triple valve of the Kunze-Knorr brake which differs from that of the original type of Lipkowski brake, and, moreover, the use of a number of spring controlled valves in this brake does not appear any more satisfactory than the leather diaphragms which were criticised in the case of the original type of Lipkowski brake. It should be added that the Kunze-Knorr has also copied a feature of the Westinghouse, which checks the rush of air from the first chamber of the two chamber brake, thus rendering the action of the brake less harsh in the case of an emergency application. There is nothing to prevent this device being added to the old type Lipkowski brake.

New type Lipkowski brake. — The Lipkowski brake originated about 1900, but it has since been modified. To-day it is a one chamber compressed air brake, one face of the brake piston always being under atmospheric pressure, while the other is subjected to pressure when the pressure in the train pipe is reduced either by the driver operating his brake valve or by a rupture of the train pipe couplings.

We will not concern ourselves here with all the constructional details of this brake in its original form, which was described in the *Génie Civil* in 1903 (1), it having at that date already been tried on the Orleans and State Railways, and also in Russia.

The Lipkowski Company attempted, before the war to make this brake as applied to passenger trains, equally applicable to long goods trains. After a series of modifications and trials, the results of which were quite encouraging, permission was obtained for a new series of trials on the French State Railway. These trials were commenced in July 1914, but were interrupted by the war. Since that time the Company has aimed at increasing the speed with which air can be released from the train pipe by means of repeating accelerators (fig. 19) which operate, not only for emergency stops, but also for ordinary or service applications. Every reduction of pressure in the train pipe brings these accelerators into action.

In the actual type of apparatus used for the trials now in progress, an initial reduction of 6.400 lb. per square inch is sufficient to apply the brake blocks to the wheels. The pressure on the wheels may then be increased progressively by means of further reductions of 3.982 lb. to 4.267 lb. per square inch. The brake can be satisfactorily graduated both for application and release.

The triple valve (fig. 20) consists of three chambers of different diameters. The middle chamber B is connected to the train pipe through a passage of small cross section and by a larger passage to the auxiliary reservoir. It also communicates with the brake cylinder and with the upper chamber C, but it is only the communication with the auxiliary reservoir which is permanent, the others being controlled by the position of the slide valve T (figs. 20 to 24) which is controlled by the spindle of a differential piston, that is to say, by the common spindle connecting two pistons of different diameters, one of which (of area S), works in chamber A, while the other (of area s) moves in chamber C. The lower part of chamber A communicates with the train pipe. The lower part of chamber C communicates with the brake cylinder.

Running position. Brakes off. — When the train pipe is charged with air to a

(1) See the *Génie Civil* for 5 December 1903.

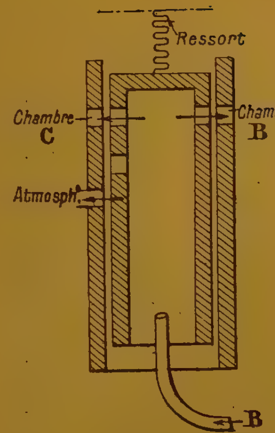


Fig. 17. — Spring compressed : air from B to C.

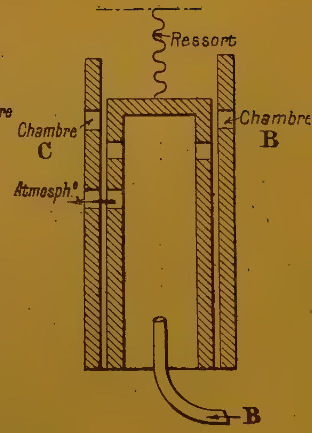


Fig. 18. — Spring extended : air in B escapes to atmosphere.

Figs. 17 and 18. — Sections of valve to vary brake power.

Explanation of French terms : Ressort — Spring. — Chambre = Chamber. Atmosph. = Atmosphere.

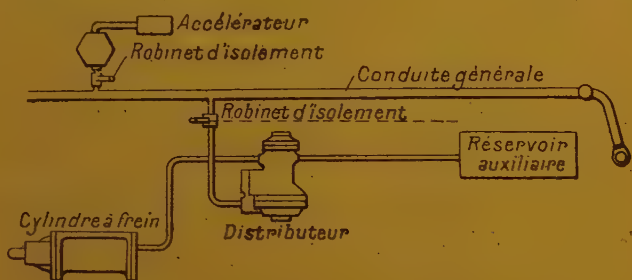


Fig. 19. — Diagram of Lipkowski arrangement.

Explanation of French terms : Accélérateur = Accelerator. — Robinet d'isolement = Isolating cock. — Conduite génerale = Train pipe. — Cylindre à frein = Brake cylinder. — Distributeur = Triple valve. — Réservoir auxiliaire = Auxiliary reservoir.

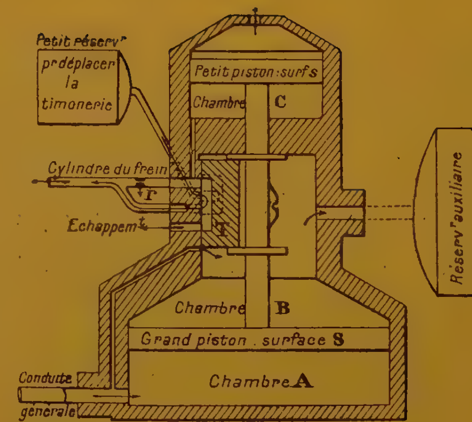
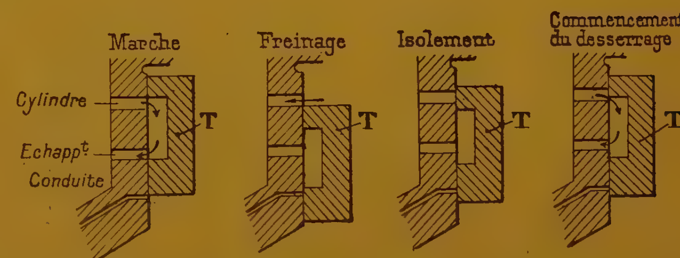


Fig. 20. — Section of Lipkowski triple valve.

Explanation of French terms : Petit piston = Small piston. — Grand piston = Large piston. — Surface S = Area S. — Échappem' = Exhaust. — Petit réservoir p' déplacer la timonerie = Small reservoir for taking up slack in rigging.



Figs. 21 to 24. — Positions of slide valve for different phases of brake operation.

Explanation of French terms : Cylindre = Cylinder. — Marche = Running position. — Freinage = Brake applied — Isolement = Lap position. — Commencement du desserrage = Commencement of release.

pressure P, the differential piston is forced to the top of its course, carrying with it the slide valve T. The brake cylinder and chamber C are in communication with the atmosphere, through the exhaust port, and the auxiliary reservoir is connected to the train pipe through chamber B. The brake is charged, this being the running position.

Brake application. — When the driver makes a reduction p in the train pipe, the differential piston is forced downwards by a force equal to : $PS - (P - p) S = pS$, and moves the slide valve, cutting off the communication between the brake cylinder and the exhaust and connecting the brake cylinder with the auxiliary reservoir through chamber B. The pressure then increases in the brake cylinder and in the lower part of chamber C which is connected therewith. If P' be this pressure which is exerted on the area s of the small piston, it tends to force the differential piston *upwards* with a force $P's$.

As soon as $P's = pS$, *i. e.*, when $P' = p\frac{S}{s}$ the differential piston ceases to descend, and gradually re-ascends as the pressure P' increases, but when the slide valve re-ascends, it cuts off communication of the brake cylinder with the auxiliary reservoir (without exhausting it), and therefore the pressure P' then ceases to increase in the cylinder and in chamber C, and consequently the piston and slide valve ceases to move upwards any further. The degree of brake application is then approximately equal to that produced by a pressure in the brake cylinder equal to $p\frac{S}{s}$. This is then practically proportional to the reduction made by the driver and is independent of the volume of the cylinder, that is to say, is unaffected by the wear of the brake blocks, since the piston stroke depends on the amount of this wear.

A further reduction of pressure is followed by a similar effect, until ultimately the pressure in the brake cylinder reaches its maximum value (1) of $\frac{PR}{R+C}$, where C = volume of the brake cylinder (including the volume of chamber C), and R = the volume of the auxiliary reservoir, plus the volume of chamber B. After this point, the pressure can increase no further under the piston C, and a further reduction in the train pipe will not cause an upward movement of the differential piston.

Release. — With a pressure $P\frac{R}{R+C}$ existing in the brake cylinder, if the driver increase the pressure in the train pipe, the piston will re-ascend when the pressure Π in the train pipe reaches a value such that :

$$\Pi S - P\frac{R}{R+C}S + P\frac{R}{R+C}s > 0$$

that is if :

$$\Pi \geqslant P\frac{R}{R+C}\cdot\frac{S-s}{S}.$$

Assuming that the pressure in the train pipe having reached such a value, the driver makes a further increase p : the differential piston will rise to the top of its stroke, connecting the brake cylin-

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(1) The pressure P' in the brake cylinder is always equal to $P\frac{s}{S}$, and cannot exceed $\frac{PR}{R+C}$; this limiting valve depending only on R, the volume of the auxiliary reservoir, in order to make this as independent as possible of the cylinder volume in the expression $\frac{PR}{R+C} = \frac{P}{1+\frac{C}{R}}$, the term $\frac{C}{R}$ should be as small as possible. Hence the volume of the auxiliary reservoir should be as large as possible. This is limited, however, by the necessity of being able to charge the reservoirs in less than 10 minutes, this being the time stipulated for the departure of the train after the engine is attached.

der and chamber B with the atmosphere. The pressure will fall therein to a pressure which we will denote by P'. The differential piston will again descend and permit a further reduction of the braking force when the resultant of the forces acting on the differential piston becomes negative, that is :

when :

$$(\Pi + p)\,S - P\,\frac{R}{R+C}\,S + P's < 0;$$

and since :

$$\Pi = \frac{PR}{R+C}\,(S - s),$$

i. e., when :

$$pS - P\,\frac{R}{R+C}\,s + P's < 0,$$

or

$$\left(P\,\frac{R}{R+C} - P'\right) s > pS.$$

But

$$P\,\frac{R}{R+C} - P'$$

is the drop in pressure in the brake cylinder. When this drop attains the value $p\,\frac{S}{s}$, the release will cease. The amount by which the braking force is diminished is proportional to the increase p in the train pipe pressure. The brake thus has a perfectly graduated release.

Emergency applications. — In order to avoid the pressure in the brake cylinder reaching its maximum too rapidly in the case of an emergency application, the port r (fig. 20) connecting chamber B with the brake cylinder is only of small section. It is, however, desirable in all cases to bring the brake blocks on to the wheels quickly with a light pressure. For this purpose a small reservoir is provided which is connected to the slide valve, and has a large passage leading to the brake cylinder. This reservoir provides the compressed air necessary for this preliminary application.

In its original form, the Lipkowski triple valve had rubber diaphragms in place of pistons S and *s*, and these proved satisfactory in service, but in order to avoid the objection which always exists to the use of rubber which is more or less exposed to oil, the inventor has replaced these diaphragms by ordinary pistons.

The Clayton-Hardy vacuum brake.

This system, the adaption of which to goods trains has been studied since 1904 in Austria, and which is in use on some mountain lines in that country, has already been dealt with in a special article in the *Génie Civil* in 1913 (1). We will here limit ourselves to describing its general principles. Figures 25 to 28 with their explanatory notes enable the essential parts to be understood.

The *vacuum* brake (or rather the *rarified air* brake) differs from the compressed air brake in that an air ejector is employed on the engine in place of a compressor.

The speed of propagation of a wave of air through vacuum exceeds 1 150 feet per second while the speed of propagation of a reduction in pressure in a pipe charged to a pressure of four atmospheres does not exceed 525 feet. The re-entry of air at atmospheric pressure into a pipe containing rarified air thus takes place much more rapidly than the discharge to atmosphere of a pipe charged with compressed air. The *accelerators* which are fitted to each vehicle are very simple devices which allow supplementary air to enter the train pipe, when a partial reduction in vacuum sets these in operation.

The last wagon of the train carries a *portable valve* (fig. 28) which is designed to allow a large inrush of air at the

(1) See the *Génie Civil* of 2 August 1913 (Vol. LXIII, No. 14).

tail of the train as soon as the reduction in vacuum made by the driver acts upon this valve. This admission of air at the tail of the train sets up a second serial action of the accelerators, from tail to head of the train.

It follows then that an emergency application (which moreover is moderated by the use of a restricted orifice between the train pipe and each brake cylinder) is propagated from the head to the tail of the train, so that the brakes begin to be applied on the *last* vehicle scarcely 2 seconds after the *first* vehicle, while the brakes do not begin to apply on vehicles in the *middle* of the train till about 4 seconds afterwards. In these emergency stops, no serious bunching up of the wagons is experienced. Moreover, as the engine brake is not applied till after that on the train, the train is never bunched up at the front, and this is a decided advantage when making a stop at the foot of an incline.

The admission of air through the tail valve causes a movement of the needle of the engine vacuum gauge, and thus affords direct evidence to the driver that the train pipe is continuous from end to end of the train. This assurance, which the driver can obtain at any time, enables any other tests of the brake to be dispensed with.

The ejector is sufficiently powerful to create the working vacuum in the cylinders of the longest train in less than 10 minutes.

The vacuum brake has no isolating cocks between vehicles. Every wagon detached is instantly braked, and it is necessary to release the brake by hand before the wagon can be hand shunted by an engine. Some engineers see herein a serious drawback. However, it is obviously good practice to brake every vehicle left on a line, even if it is necessary to release the brake by hand before hand shunting the wagon.

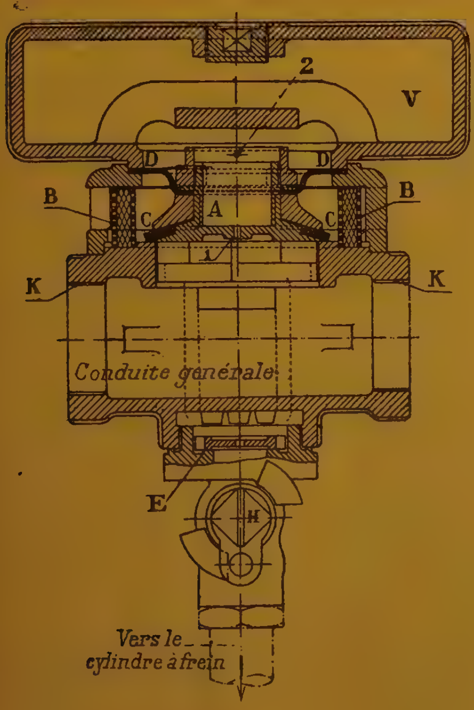


Fig. 25. — Rapid acting valve for freight wagons.

When a sudden entry of air is made into the train pipe, the restricted orifice 1 is not sufficiently large to pass sufficient air into the vacuum chamber V.

Owing to the greater pressure on its under side, the diaphragm valve A lifts and allows atmospheric air to enter the train pipe until orifice 2 has allowed sufficient air to enter chamber V, so that the same pressure exists in this chamber as in the train pipe, when the valve closes by its own weight.

A, valve; — B, dust excluder; — C, rubber washer forming a seating; — D, rubber diaphragm; — E, moderating valve checking the admission of air into the brake cylinder below the piston; — H, isolating cock; — K, screwed sockets for train pipe; — V, vacuum chamber; — 1, 2, orifices for the passage of air.

Explanation of the French terms : Conduite générale = Train pipe. — Vers le cylindre à frein = To brake cylinder.

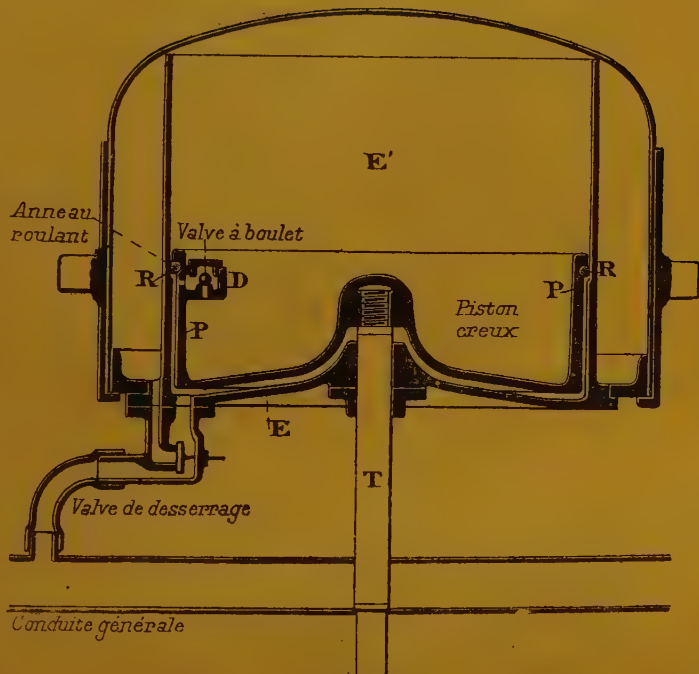


Fig. 26. — *Brake off, vacuum in train pipe.* — The ejector maintains a vacuum in the train pipe and consequently in space E below the piston. If there is any air in space E′ above the piston, it will lift the ball valve D and escape by way of the train pipe. The pressure is thus the same in spaces E and E′, and the piston falls to the bottom of the cylinder under its own weight. The brake is off.

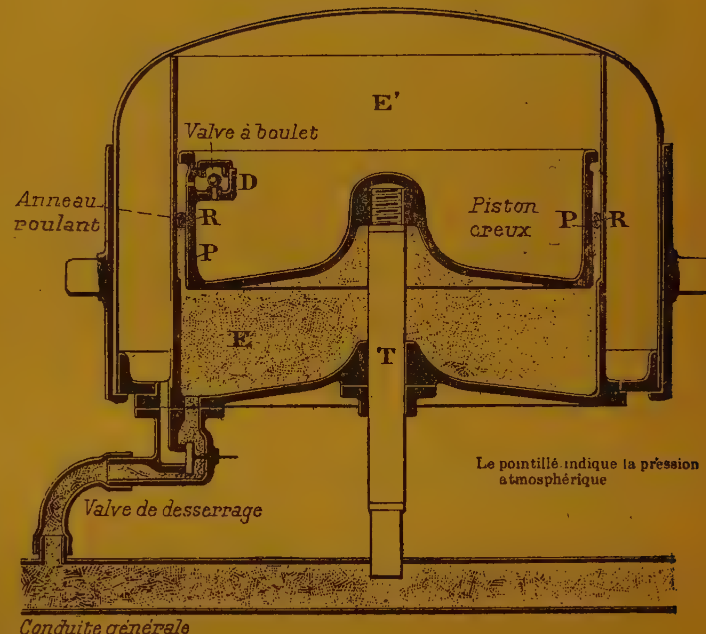


Fig. 27. — *Brake applied by air being admitted to the train pipe.* — Air, on being admitted to the train pipe by the driver, or by a breakage of the train pipe, holds the ball valve D upon its seat and causes piston P and its rod T to move upwards. The rubber rolling ring, which moves upwards in consequence of the movement of the piston, seals the space E′ above the piston.

Figs. 26 and 27. — Sections of Clayton-Hardy brake cylinder.

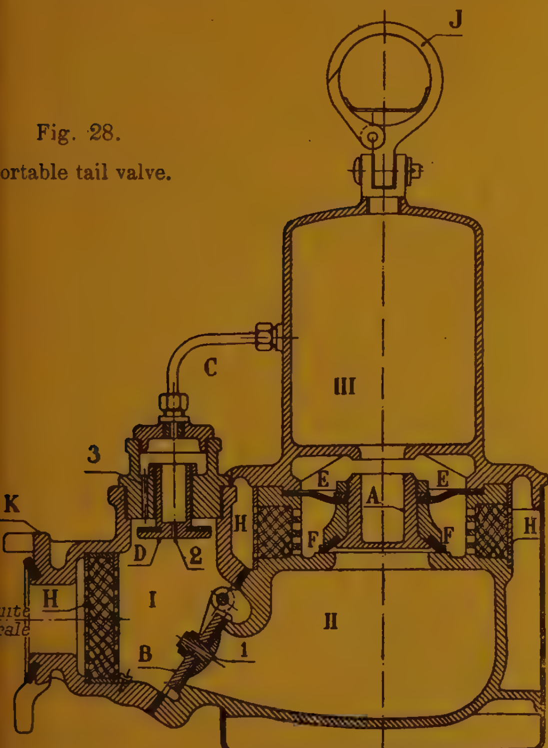
Explanation of French terms : Anneau roulant = Rolling ring. — Valve à boulet = Ball valve. — Piston creux = Piston head. — Valve de desserrage = Release valve. Conduite générale = Train pipe. — Le pointillé indique la pression atmosphérique = Shaded area represents atmospheric pressure.

It is another matter in the case of loose shunting done with an engine. It would in this case be necessary, before uncoupling, for the shunter to release the brakes of the vehicles to be detached, and this might result in a certain loss of time [1]. With the compressed air systems in which cocks are provided which the shunter closes before uncoupling, there is a reserve of compressed air left in the wagons, which it is possible to use during shunting operations, as is done in the United States.

It appears, however, to be possible to fit valves on the train pipe to fulfil the same role as the isolating cocks on the train pipe in the case of the air brake, if it is found necessary to do so.

Fig. 28.

Portable tail valve.



A, valve; — B, flap valve pierced by an orifice 1; — C, pipe connecting chambers I and III; — D, intermediate valve pierced by a small orifice 2; — E, rubber diaphragm; — F, rubber seating washer; — H, dust excluder; — J, handle and hook for suspending the apparatus; — K, coupling to attach to hose-coupling of last vehicle; — I, vacuum chamber in direct communication with the train pipe; — II, lower vacuum chamber; — III, upper vacuum chamber.

The proportions of the valve and orifices are such that the valve A, which admits air from the atmosphere, opens a fraction of a second after the rapid acting valve if the last vehicle in the train has closed, and closes after about two seconds.

Operation. — With a vacuum existing in chambers I, II and III, if a small amount of air is admitted to the train pipe, this air, flowing through orifices 1 and 3, effects the same reduction of vacuum in chambers II and III; the diaphragm valve A is unaffected and does not lift.

If on the other hand air is admitted to cause a rapid and large reduction of vacuum, the intermediate valve, which is pierced by the small orifice 2, is forced upwards, closing orifice 3. Consequently the air enters chamber II more quickly than with chamber III, and the equilibrium of valve A is disturbed. This valve lifts and allows a sudden entry of atmospheric air through H and F into chamber II, where the pressure increases until it lifts flap valve B. Atmospheric air thus rushes rapidly into the train pipe from the tail towards the head of the train.

We have already seen that in the case of the compressed air brake as applied to the freight trains, it is necessary, if the time for the reduction in pressure to propagate itself along the train is 6 seconds, to lengthen the time taken to fill the brake cylinders from 6 to 36 seconds. In other words, the time taken to fill the brake cylinder should be six times as great as the time of propagation. The time of propagation of the change of pressure being $6'' \times \frac{160}{360} = 2.8$ seconds in the case of the vacuum brake, the time taken to fill the cylinders will be, other things being taken as equal, $6 \times 2.8 =$

[1] In the shunting trials carried out at Creil in June 1921, it was proved that in practice no time is lost through this cause.

17 seconds. A full application is thus obtained in an appreciably less time than with the compressed air brake, and this explains the fact that shorter stops are made with the vacuum brake.

Also, the upper part of the Clayton-Hardy brake cylinder which acts as an auxiliary reservoir retains for a long time sufficient vacuum to give an effective brake power, and this feature, which is due to the airtight joint made by the simple rubber rolling ring in conjunction with a very simple ball valve, makes it possible to rely upon having a vacuum of 13.780 inches under all circumstances while the train is running.

It should be noted that the piston rod does not pass through the said reservoir, so that there is no fear of leakage from this cause.

Brake trials carried out in 1921.

First series of tests of the Westinghouse brake on the Paris-Lyons-Mediterranean Railway. — In view of the various systems which we have been considering, Mr. Claveille, the Minister of Public Works in 1919, on the advice of the Brake Commission appointed by the Railway Technical Operation Committee, selected the vacuum brake for use on freight trains, and decided to equip a train with the Clayton-Hardy brake, in order to demonstrate it to allied and neutral powers, but on account of the opposition of the railway companies, who with one exception had shown a decided preference for the compressed air brake, the present Minister, Mr. Le Trocquer, authorised the Paris-Lyons-Mediterranean Company to repeat the tests with the Westinghouse brake, which they had already successfully carried out in 1913. His predecessor had also already authorised the Lipkowski Company to resume the tests which had been interrupted at the end of July 1914.

The trials on the Paris-Lyons-Mediterranean were carried out in March and April last with every success. On steep inclines, *retaining valves* were used in place of the special brakesmen employed in 1912-1913.

The length of the test trains which had been 2 493 feet (1 300 t.) at that time, was increased to 2 887 feet (1 576 t.)

In order to obtain an exact indication of the reactions caused, either by closing the regulator or by applying the brakes, « ball and incline plane » shock recorders were used. The magnitude of the shocks to which a wagon fitted with this apparatus is subjected is indicated by the number of balls which have fallen from their seatings as a result of these shocks. Each case consists of 10 inclined planes 0.591 inch in length arranged on either side of a middle partition, the inclinations with the horizontal being respectively : $^{25}/_{1000}$, $^{50}/_{1000}$, $^{75}/_{1000}$, $^{100}/_{1000}$, $^{150}/_{1000}$, $^{200}/_{1000}$, $^{300}/_{1000}$, $^{400}/_{1000}$, $^{600}/_{1000}$ and $^{800}/_{1000}$, the lower ends of these inclined planes being lower than the upper ends by the following amounts respectively: 0.014764, 0.029528; 0.04429; 0.0591; 0.0886; 0.118; 0.157; 0.197; 0.236; 0.354 and 0.472 inch. On each of these inclined planes is placed a polished steel ball weighing about 0.0044 lb.

Each case of balls is mounted on a board which can turn about a transverse axis through its centre line. A spirit level enables the board to be set in a truly horizontal position and to be adjusted in accordance with the variations of the gradients of the line.

Running tests. — A first series of trials were carried out : 1° with trains consisting of 50 American wagons and 3 observation cars, that is to say, 53 vehicles or 207 axles, on the Villeneuve-Saint-Georges to Montereau line; 2° with trains of 29 to 37 American bogie wagons on the Freissinouse to Gap, La Beaume to Die, and La Chapelle-Laurent to Brioude lines, the ruling gradients on these lines being 1 in 40, 1 in 50 and 1 in 33.3 respectively.

The following table shows the conditions under which these tests over heavy gradients were carried out. The results were in every way satisfactory.

SECTION OF LINE.	Maximum gradient.	Number of engines.	Weight of train excluding engine and tender.	Number of axles excluding engine and tender.	Length including engine and tender		Number of vehicles.		Number of retaining valves in operation.
					of train.	of train pipe.	Total.	Braked.	
	‰		In t.		In feet.	In feet.			
La Freissinouse-Gap. .	2.5	2	811	111	1 240	1 398	29	25	22 { 30.87 to 4.42 lb. / 17.64 to 2.21 lb.
La Beaume-Die	2.0	2	1 004	135	1 480	1 660	35	24	52.91 to 2.21 lb.
La Chapelle-Laurent-Brioude	3.3	1	811	142	1 490	1 745	37	33	33 { 33.07 to 4.42 lb. / 39.68 to 2.21 lb.

A second series of trials were carried out from 11 to 16 April 1921 with trains of European rolling stock (80 twenty ton open wagons). These trials were similar to those carried out with the American rolling stock between Villeneuve-Saint-Georges and Montereau.

The first four trains had a total weight of 1 576 t., excluding the engine and tender; the fifth which was composed of empty wagons only, was 1 007 t.

A complete account of these trials will be found in the *Revue générale des Chemins de fer* for July 1921, giving tables showing the composition of each of the trains and the results obtained, including the number of vehicles equipped with cases of balls, and the number of balls which fell from their seatings during the tests, either upon the closing of the regulator or on account of the actual application of the brakes. The closing of the regulator causes a rapid bunching up of the train, the effect of which on the cases of balls can be distinguished from that produced by the actual application of the brakes, which, by reason of the slow and progressive building up of the pressure in each brake cylinder, takes rather longer to manifest itself.

The number of balls thrown out by closing the regulator and by the application of the brakes are about the same in number, and as a rule only a few; but while the balls which fall out on closing the regulator do so by reason of the shocks produced by one vehicle striking another as the train bunches up upon the engine, those which fall out during the application of the brakes do so in most cases under the effect of their own inertia, which is sufficient to cause some of them to leave their seatings during the period of retardation without any shock being produced.

There are, however, some shocks produced during the brake application, though these are not mentioned in the trials with the American rolling stock (this shows the advisability of carrying out such tests with trains as long and as heavy as possible), but these shocks compared with those caused by closing the regulator, are as a rule, of small importance.

It was in the test in which the couplings were broken between the 66th and 67th vehicle of the train on 13 April that the greatest number of balls were found to be thrown out (six balls being thrown out behind in vehicle No. 65 and six balls in front in vehicle No. 93).

This is due to the fact that the front portion of the train which was separated from the rear portion on the breaking of the couplings coming to rest more rapidly than did the rear portion, since the brake percentage was 40 % for the first portion, while it was only 28 % for the rear portion, and impact took place between the rear and front portions. This incident is therefore attributable to the unequal distribution of brakes along the train, rather than to the type of brake under trial.

Standing tests. — These tests have shown that :

1° The time which elapses between the moment at which the driver operates the brake valve and that at which air commences to flow into the brake cylinder of the 93rd vehicle varies according as to whether there are or are not a considerable number of vehicles in the train which are piped only. The time is from 7.5 to 10.5 seconds when nearly all the vehicles are braked, and from 10 to 13 seconds when the train includes groups of from 20 to 91 piped vehicles;

2° The time which elapses between the moment at which the driver operates the brake valve and that at which air commences to exhaust from the brake cylinder of the 93rd vehicle varies from 11 to 23 seconds when the brakes have been applied by making a reduction varying from 7.111 lb. to 21.334 lb. per square inch, and when the vehicles are nearly all braked. This time is from 7 to 10 seconds when the brakes have been applied by making a reduction of 7.111 lb. per square inch and where the train includes groups of 20 to 91 piped vehicles;

3° Eight or nine minutes after the engine has set back on to a train of 93 vehicles, all braked, and the train pipe has been coupled up, about 56.88 lb. pressure can be obtained at the tail of the train, this being sufficient to test the brakes and to start away.

First trials with Lipkowski brake on the State Railway. — The Lipkowski Company, after having improved their apparatus, proceeded to make a series of tests over a line with easy gradients from Epône to Plaisir-Grignon. The following table summarises the conditions under which they were carried out.

SECTION OF LINE.	Maximum gradient.	Number of locomotives.		Weight of train excluding locomotives.	Number of axles excluding locomotives.	Number of vehicles.		Method of coupling.
		Outward journey.	Return journey.			Total.	Braked	
Epône to Plaisir-Grignon . .	0.9 °/o	2	1	1 200	160	80	18, 38, 55 or 80	Loose.
A dynamometer car, either at the head or tail of the train, and three observation cars.								

With the proportion of wagons braked ranging from 18 out of 80 up to all the wagons being braked, and with the braked wagons and loaded wagons distributed in various ways throughout the train, emergency stops, service stops and moderate applications followed by a release have been performed in a satisfactory manner. In the case of the emergency stops, the stopping distances were remarkably short.

After the completion of these trials, the Company was authorised to take part in the final trials of the three systems, provided that satisfactory trials were made over a line through mountainous

country. This was done in November last on the Lioran line of the Orleans Railway, with satisfactory results. The double control and retaining valve invented by Mr. Seguin and described earlier in this article was used successfully.

First trials of the vacuum brake on the Northern Railway. — The first trials with the Clayton-Hardy vacuum brake were carried out between Creil and Beauvais, and between Amiens and Doullens, during April and May last. The wagons were fitted with automatic slack adjusters for taking up the wear of the blocks, and with a rigging arranged to give a variable leverage ratio, according as whether the wagon is empty or loaded.

In the first place, a train of 75 wagons was run between Creil and Beauvais, 29 of the wagons being loaded. The number of wagons braked were 16, 30, 57 and 74 in successive tests.

A second train composed of 28 wagons loaded with 20 tonnes and braked at 41 % of the total weight, plus 4 light observation cars braked at 71 % and two unloaded dynamometer cars, making a total of 34 wagons, having a weight of 983 tonnes and hauled by two engines, was run between Amiens and Doullens.

On the return journey the train was increased to 51 wagons made up as follows : 30 empty open wagons braked at 65 %, 15 loaded open wagons braked at 23 %, 4 light observation cars braked at 41 %, and 2 unbraked dynamometer cars.

The results which were obtained were remarkable.

Final comparative trials of the three rival systems.

As we have said above, the official Commission have lately conducted two series of comparative trials between the Westinghouse, Lipkowski and Clayton-Hardy systems, the first from 12 to 14 December 1921 on the line from La Chapelle-Laurent to Brioude; and the second from 17 to 22 December on the line from Melun to Montereau. It is impossible as yet to give any information as to the result of these trials, as this cannot be published until the Commission has submitted to the Minister of Public Works the results of these trials and the conclusions arrived at.

[656 .222.4]

Graphical determination of a diagram showing the running of trains.

Figs. 1 and 2, pp. 1312 and 1313.

In the 1 January 1922 number of the *Glasers Annalen*, Mr. Caesar, Oberregierungsbaurat of Kattowitz, suggests a graphical method for tracing a curve representing the running of a train when the dimensions of the engine, the composition of the train and the profile and section of the line are known.

The principles on which his method are based are given in the following account.

The line is divided into a number of sufficiently short sections as to make it possible that over the whole length of each one of them the force available for acceleration may be considered constant. The determination of this force of acceleration is found as follows.

In the first place a curve is drawn out according to Strahl's method (*Zeitschrift des Vereins deutscher Ingenieure*, 1913) or else to that of Obergethmann (*Glasers Annalen*, 1909) representing as a function of the speed the maximum indicated tractive effort of the locomotive. Subtracting the resistances of the mechanism and taking into account the limiting effect of adhesion, we obtain line 1 shown in figure 1 which gives the maximum effort at the rim of the wheel; if we now subtract the resistances due to the carrying axles of the engine, the wind, and those of the train (equal to the weight of the train multiplied by the resistance calculated at different speeds), we obtain the line 2 which represents the force at our disposal for acceleration at different speeds on straight and level lines. For rising or falling gradients, the action of gravity must be taken into account by plotting it above or below the axis giving the values of x so as to increase or decrease the ordinates in proportion to the weights of the train multiplied by the incline of the line. The resistances due to curves will be carried above the axis so as to be subtracted from the tractive effort.

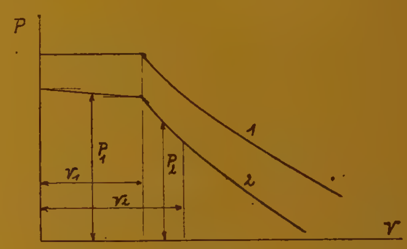


Fig. 1.

This being stated, we first take into consideration the period when starting, corresponding to the sensibly horizontal portion of the net force diagram and assuming the resultant of the forces P_1 applied to the train to be constant. What has to be determined is the distance run over and the time taken from the start until the speeds V_1 (km per hour) or v_1 (m. per second) is reached. To obtain this, OP_1 proportional to the effort P_1 is marked off to a convenient scale on the x axis to the left of the origin point, and

on the y axis a length OA_1 proportional to $\sqrt{\frac{m}{2}}\, v_1$, m representing the mass of the whole train. The perpendicular raised at A_1 on the line A_1P_1 cuts the x axis at the point C_1 and the length $OC_1 = l_1$ represents the distance run over. In fact from the similar right angled triangles we get:

$$P_1 \cdot l_1 = \left(\sqrt{\frac{m}{2}}\, v_1\right)^2 = \frac{mv_1^2}{2} \qquad (1)$$

an equation proving that the work of force P_1 over the length l_1 is equal to half the kinetic energy acquired by the train.

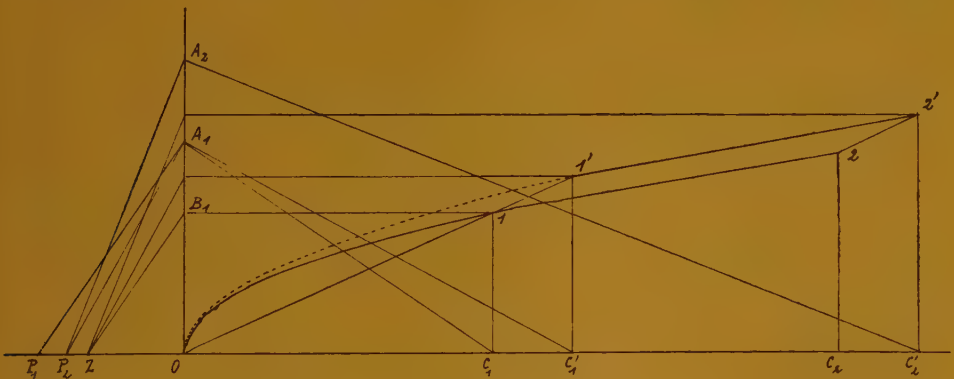


Fig. 2.

To obtain the time t_1 we mark off on the x axis OZ equal to $\sqrt{2m}$ and through the point Z draw a parallel to P_1A_1 intercepting on the y axis a length OB_1 which represents the time t_1. As will be seen, the similar triangles give:

$$\frac{OB_1}{\sqrt{2m}} = \frac{\sqrt{\frac{m}{2}}\, v_1}{P_1};$$

from which

$$OB_1 = \frac{v_1}{\frac{P_1}{m}} = \frac{v_1}{j_1} = t_1,$$

j_1 representing acceleration. This diagram gives the point 1 of the parabola representing the starting of the train, the equation for which is:

$$t^2 = \frac{2l}{j_1} = \frac{2m}{P_1} \cdot l.$$

The speed at point 1 is given by the tangent which the curve makes with the vertical at that point; the mean speed over the length run l_1 is half this and proportional to the tangent of the angle $O1C_1$.

We will now consider a second section, that run over while the speed rises from v_1 to v_2, the train being acted upon by an accelerating force P_2. The curve relating to this section is a segment of the parabola representing the running of the train from the origin under the action of force P_2.

The length of its projection on the x axis is determined by the intersections with this axis of the perpendiculars raised on the straight lines joining the point P_2 to the points A_1 and A_2 of the ordinates

$$\sqrt{\frac{m}{2}}\, v_1 \text{ et } \sqrt{\frac{m}{2}}\, v_2.$$

The point $1'$ from which it is drawn is found on the straight line $O1$ produced,

the mean speed being $\frac{v_1}{2}$ over the imaginary course $01'$ as well as over the course 01_1; the tangents at the points 1 and $1'$ have the same inclination, the momentary speed at both these points being v_1. The times taken to reach the points $1'$ and $2'$ are obtained by drawing through the point Z parallels to the straight lines P_2A_1 and P_2A_2 and the time really taken up in travelling over this second section is given by the difference between the ordinates of the points $2'$ and $1'$. The time taken from the origin and the distance travelled over to the origin of the second section being respectively t_1 and l_1, the true position of the curve will be obtained in carrying it parallel to itself from $1'2'$ to 1 2 in the direction $1'10$.

In the same way may be found a third point marking the end of a section travelled over by an accelerating force P_3, the speed increasing from v_2 to v_3.

In practice speeds are expressed in kilometres per hour, and it will be necessary to substitute these speeds v by $\frac{V}{3.6}$. The mass of the train m is expressed as a function of the weight G given in tons by

$$m = \frac{1\,000\,G}{9.81}$$

and, in order to take into account the inertia of the revolving masses, it is further multiplied by the factor 1.07. If we choose for our scales $\frac{1}{100}$ mm. for a force P of 1 kgr. and $\frac{1}{10}$ mm. for a length l of 1 m., the equation (1) becomes

$$\frac{1.07 \cdot 1\,000 \cdot G}{2 \cdot 9.81 \cdot}\left(\frac{V}{3.6}\right)^2 \frac{1}{1\,000} = \frac{P}{100} \cdot \frac{l}{10},$$

that is to say, that for a speed V there will be a corresponding equal ordinate from the point A equal to

$$\sqrt{\frac{1.07 \cdot G}{2 \cdot 9.81 \cdot 3.6^2}}\, V = 0.0648 \cdot \sqrt{G} \cdot V.$$

As we are considering a train of given weight G, the product $0.0648\sqrt{G}$ is constant. When G = 575 tons ordinates equal to 1.55 V should be taken.

The length to which OZ should be marked off to represent $\sqrt{2m}$ depends on the scale of the ordinates of the points A and the scale on which it is desired to read the time. The time being represented to a scale of n millimetres per minute, it is easy to show that we must make OZ equal to a number of millimetres given by

$$OZ = \frac{1}{100} \cdot \frac{1}{10} \cdot 1\,000 \cdot \sqrt{\frac{2 \cdot 1.07}{9.81}} \cdot n \cdot \sqrt{G}$$
$$= 0.0778 \cdot n \cdot \sqrt{G}.$$

As speed increases acceleration decreases, and the perpendiculars to the straight lines PA cut the x axis at sharper and sharper angles. To reduce errors in drawing the diagram, we can make the lengths OP on a larger scale to that given; the distances covered will then be measured on a reduced scale in the same proportion.

When acceleration becomes nil, speed being constant, the running of the train is represented by an oblique straight line having the same direction as the tangent of the last point of the parabola.

At points where acceleration undergoes sudden changes, as for instance when entering on an up or down gradient or a curve, the hypothesis of constant acceleration during a certain time requires that it is necessary that these points are made to coincide with the end of one period and the origin of the next. In this case we have to solve the inverse problem-

to the preceding one, that is to say, instead of stating the final speed and finding the distance travelled, we take the latter quantity and provisionally allowing a mean acceleration which can be rectified afterwards, the speed is determined at the end of the period. This determination is possible, for we know the abscissa of the point 1′ by means of the right angled triangle $P_2A_1C'_1$, and that of the point 2′, because its length of travel l_2 is given. It is only necessary to find the apex A_2 of the right angled triangle $P_2A_2C'_2$ in order to get the length OA_2 from which is found the speed V_2.

Acceleration is some times negative : this may be the case when entering a rising gradient or curve; it also happens when the brakes are applied when a slack is required or for a stop. The distances during this braking action are dealt with in the same way as during the starting operation by dividing them up in order to obtain greater accuracy, as resistances and the braking effort vary with the speed.

The acceleration being negative, it will be necessary to mark off the lengths OP to the right of the origin point, but it is possible to obtain the distance run between a speed V_n and a slower speed V_{n+1} by marking off the length OP_n as for a positive acceleration. In any case the parabolic segment thus obtained should be gone over backwards as with a positive acceleration, that is to say, from right to left. It will be necessary therefore, in order to bring it end to end with the curve relating to the preceding distances run over to turn it through 180°. The curve representing the distance run during the application of the brakes when making a stop turns upwards with an increasing inclination and finally becomes tangential to the vertical at the moment of stopping.

E. M.

[625 .143.3]

Accidental breakages of rails,

By CH. D.

Figs. 1 to 14, p. 1318 and 1320.

(*Le Génie Civil.*)

The *Génie Civil* has recently summarised an important memorandum published by Mr. Ch. Fremont upon the premature wear of rails [1] and sets forth the principal causes. Mr. Fremont has just published another memorandum in which he completes his preceding article by particularly examining the causes of rails breaking and splitting at the ends in the web [2]. Below we give a summary of this memorandum.

Breakages of rails at the end in the web. — Breakages are much more frequent at the ends than elsewhere [3], and it is fairly frequently found that the steel, at the point of breakage, is of medium quality, according to the results of the tests made, as is usual, in the direction of the rolling of the rail.

The examination of these fractures in the web shows numerous cracks both old and progressive which are attributable to the blows received at the rail joints. The blow of the wheel, which is more intense at the joint than at other places, by reason of the bending, produces a greater amount of elastic work which, instead of being equally distributed, is localised within a restricted area, and the stress per unit is therefore much higher and exceeds the local limit of elasticity.

In such conditions the repeated stresses fatigue the metal, cracks are started and spread from particle to particle of impurity, the more easily when the metal is brittle and contains such impurities — notably non-metallic ones — and naturally more rapidly when the blows are heavy and frequent.

With steel of average quality, a number of rails when supplied have incipient cracks in them. It is evident that the creation and growth of cracks takes place much more readily when the metal is brittle and contains a segregated portion of the original ingot. During the spreading of the cracks, the separated surfaces are hammered together by each fresh blow and breaking off any projecting particles gives the fracture a glossy appearance. Cracking generally occurs at the trailing end of the rail, because this portion receives a direct blow; cracks also sometimes occur at the leading end, the blow on the trailing end of a rail being transmitted on to the leading end of the preceding rail through the medium of the fish-plate. If the rebound upon the leading end (weaker than the original blow) produces cracking, it is because the metal is more brittle. It is to be noted, however, that various factors effect this blow, as for instance the shape and size of the fish-plate. In

(1) See the *Génie Civil* of the 19 November 1921, vol. LXXIX, No. 21, p. 429.

(2) *Causes de ruptures accidentelles des rails*, by Ch. FREMONT, published by the author, and the Dunod Library, Paris.

(3) See a note furnished by Mr. Fremont on this subject to the *Academy of Science* on 9 August 1920, and reproduced in the *Génie Civil* of 21 August 1920, vol. LXXVII, No. 8, p. 159.

order to demonstrate the influence of brittleness of steel upon the production of cracks at the joints, Mr. Fremont took ten pieces of rails with cracks of various types in the web at the ends (figs. 1 to 10). He cut out from the centre of the damaged rails test pieces for shock tests 8 × 10 mm. (5/16 × 3/8) inch) in section, three being lengthways with the rail and four crossways.

On examination of the cracks in the webs (figs. 1 to 10), it will be noticed that they all have the appearance of cracks due to metal brittleness without lateral deformation, and that, except for the starring round the bolt holes, the general direction of the cracks is longitudinal to the rail. It is therefore across the lamination that the webs work under the blow of the wheel.

The results of the shock tests are given in the following figures :

Amount of work required to break unnotched test pieces 8 × 10 mm. (5/16 to 3/8 inch) taken from the web at the ends of ten rails [1].

NUMBERS OF RAILS.	Test pieces taken lengthwise of the rail.			Test pieces taken crosswise of the rail.			
	Work in kgrm. (in foot-pounds).			Work in kgrm. (in foot-pounds).			
1	4 (28.9)	20 (145)	18 (130)	6 (43.4)	8 (57.9)	7 (50.6)	7 (50.6)
2	28 (203)	30 (217)	30 (217)	16 (116)	14 (101)	14 (101)	12 (87)
3	30 (217)	27 (195)	25 (181)	18 (130)	15 (109)	13 (94)	13 (94)
4	16 (116)	22 (159)	20 (145)	6 (43.4)	18 (130)	8 (57.9)	4 (28.9)
5	28 (203)	28 (203)	27 (195)	15 (109)	15 (109)	15 (109)	13 (94)
6	22 (159)	22 (159)	22 (159)	10 (72.3)	7 (50.6)	5 (36.2)	4 (28.9)
7	26 (188)	30 (217)	29 (210)	10 (72.3)	16 (116)	18 (130)	18 (130)
8	18 (130)	8 (57.9)	14 (101)	9 (65.1)	8 (57.9)	8 (57.9)	10 (72.3)
9	10 (72.3)	20 (145)	20 (145)	4 (28.9)	9 (65.1)	5 (36.2)	12 (87)
10	18 (130)	23 (166)	28 (203)	8 (57.9)	14 (101)	17 (123)	18 (130)

It is to be noted that for an unnotched test piece of 8 × 10 mm. (5/16 × 3/8 inch) ordinary rail steel may give up to 50 and even 60 kgrm. (361 to 433 foot-pounds). Under 20 kgrm. (145 foot-pounds), the steel is brittle, and from 30 to 40 kgrm. (217 to 289 foot-pounds) it is of good quality.

Inspection of the figures in the table shows that across the rail all the rails are more or less brittle in the cracked webs, and that lengthwise not one is of good quality. In regard to No. 3, the brittleness across the rail is due to the presence of a large amount of non-metallic enclosures, distributed in small form, throughout the whole piece of rail, and in respect of the other nine to segregation of the steel, as was shown by macrographs.

To sum up, in order to avoid fractures of rails in the web at the ends, only rails which are not brittle across the rail should be accepted. A test for brittle-

[1] The type of machine on which these tests were carried out was the *Fremont*.

ness in such cases may be economically effected by taking test pieces 8 × 10 mm. (5/16 to 3/8 inch) in this direction from a piece of the rail which has been subjected to shock test, and from the end where cut off.

Figs. 1 to 10. — Examples of rails with cracks in the web at the ends.

Cracking of rails. — Cracks very frequently appear on the running surface of rails. On one railway system it was noticed that these cracks affected one third of the rails in use. Breakages, however, were not more numerous on this railway than on others.

Such cracks have been known for a long time, and were principally commented upon by Stead twenty-five years ago. The starting point of the cracks is often attributed to «hammer-hardening». In order to prove whether this was so or not, Mr. Fremont tested an old profile rail which had been in use for more than twenty-five years, and which had been taken up in consequence of the discovery of the cracks. The rail was of mild steel from 36 to 43 kgr. (72.57 to 86.68 lb. per yard). Shock tests were made with 14 unnotched test pieces and gave results varying between 2 and 48 kgrm. (14.5 to 347 foot-pounds).

In order to find out whether the brittle-

ness was due to « hammer-hardening », Mr. Fremont took an uncracked portion of the surface of the rail, and from this took 44 test pieces of 8 × 10 mm. (5/16 to 3/8 inch) which he submitted to shock tests, without having them notched; 22 were tested so that the face corresponding to the wearing surface was put in tension, and the remaining 22 in the contrary direction. For the first 22, the faces of which in tension corresponded to the exterior surface of the rail, the amount of work varied from 40 to 17 kgrm. (289 to 123 foot-pounds), with an average of 26 kgrm. (188 foot-pounds). For the 22 others, the amount of work varied from 24 to 1 kgrm. (174 to 7.2 foot-pounds) with an average of 13 kgrm. (94 foot-pounds); seven test pieces were very brittle.

The slight resistance to the shock test of the first series arises from the fact that the metal is very much « hammer-hardened »; the metal had undergone an excessive elongation which had used up a portion of its natural resistance. But the test pieces, the faces of which in tension were opposite to the wearing surface gave a lesser resistance. Hence, superficial « hammer-hardening » is not the cause of brittleness.

Mr. Fremont has, however, verified this in another way, by submitting a piece of the same rail, without cracks, to bending test by putting the top flange of the rail in tension. In these conditions, when cracks exist, the rail breaks suddenly; this, however, did not break, and test pieces taken from the most bent and deformed portion, and afterwards submitted to shock tests, gave a resistance of 27 to 28 kgrm. (195 to 203 foot-pounds).

Further, cuts taken from the rail longitudinally, then polished and lightly attacked by iodine, showed in the microscope, cracks starting from the centre of zones of impurities and spreading perpendicularly thereto; that is to say transversely to the longitudinal axis of the top flange, and travelling from one particle of impurity to another.

To sum up, this rail of very mild steel, very hard on the surface, does not present in any way the smallest crack attributable to « hammer-hardening » on the surface. The cracks arise from the segregated portion of the metal which is in the middle of the top flange : owing to the action of blows and vibrations they travel from one particle of impurity to the other. Other tests carried out on a rail still harder confirmed the view that the hardening of the running surface was not the starting point of the cracking.

In regard to cracks, they are co-incident with the superficial temper of the running surface of the rail; a peculiarity studied more than twenty-five years by Osmond. This tempering may be produced as a result of vigorous friction of short duration, such as slipping and sliding due to sudden applications of the brake on trains.

The thickness of the hardened layer is, however, very small: about one tenth to one fifth of a millimetre (0.004 to 0.008 inch). This layer is supported by a more ductile zone of metal which, under pressure, gives way and elongates to such a degree that lateral seams are formed which cause cracks in the superficial layer. If the metal is not brittle the lower layers remain intact; if the metal is brittle the flaws spread to the interior of the rail.

The spreading of the cracks to the interior of the top flange takes place slowly and progressively, but very often the lower end of this transverse crack is far from being parallel to the running surface of the rail, as one might suppose would be the case. Thus, figure 11 shows two aspects of a break produced by bending a small sheet about 1 cm. (0.394 inch) thick cut from a much cracked running surface of a rail head.

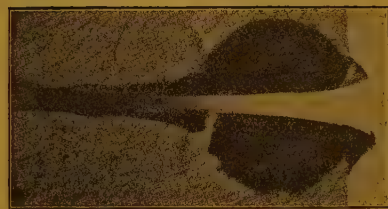


Fig. 11. — Deep crack-very irregular.

Fig. 12. — Example of internal fissure and an external crack in a rail.

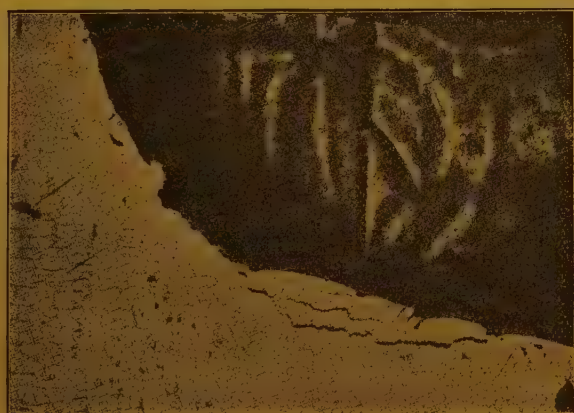


Fig. 13. — Rail broken across cracks without following their contour.

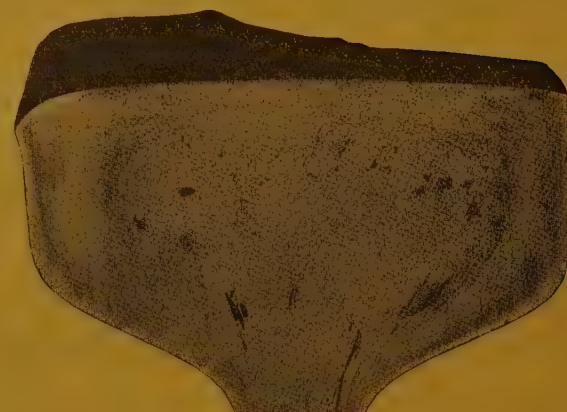


Fig. 14. — Macrograph showing segregation which caused breakage by cracking.

The granular portion is the final break by bending where cracked, and the black portion is the slow and progressive cracking.

In numerous cases, rail breakages happen in a way manifestly out of relationship to the position of the cracks. For instance, figure 12 shows an example of a rail broken as a result of an internal fissure-independently of external cracks. Figure 13 confirms the existence of this cause of failure which is due to segregation, and figure 14 shows this clearly. Internal cracks — generally resulting from segregation — are very often the cause of breakages.

In conclusion, it may be said that the production of cracks (which, being defects, are naturally undesirable) result from the very duty that the rail ought to perform. Obviously one may endeavour to produce special steels which would not harden so easily, but a notable increase in the price of the rails would result therefrom.

In any case an ordinary steel which is neither segregated nor brittle is sufficient to ward off breakages due to cracks, and these therefore are the two conditions to specify in order to obtain a metal giving every guarantee from the point of view of safety.

[351 .812.1 (.44)]

The new legal regime of the French Railways. (1)

(*Annales des Chemins de fer et Tramways.*)

INTRODUCTION.

A new régime for the great railway systems has come into force. It dates from the bill presented to the Chamber of Deputies on 18 May 1920, which approved an agreement made on 17 May 1920 between the Minister of Public Works acting on behalf of the Government, and the representatives of the great railway systems. The final agreement is dated 28 June 1921 and the act approving it is dated 29 October 1921. The working out and carrying through of this important reform has, therefore, taken a year and a half.

The new régime does not completely abolish that of the agreements of 1883 : the system of concessions is retained with its general provisions and its limitations of term, the working of the railways remains in the hands of the Companies holding the concessions in accordance with their articles and the by-laws and regulations in force before 1921. But though the structure as a whole has been retained, its details have been modernized and adapted to the financial and economic situation arising from the war.

In view of the fact that the war had enormously increased the burdens and loans of the State, it was necessary to relieve the Budget and to strengthen the securities of the Companies, who, with their good-will, are the bankers of the State. This led to the replacement of the guaranteed interest for the concession-

(1) See note in the *Annales des Chemins de fer et Tramways 1922*; parts 1, 2 and 3 : pp. 1 to 40 and parts 4, 5 and 6 : pp. 41 to 75.

holding systems, and the unlimited Treasury subsidy to the State railway system, by a payment based on tariff rates by applying the balancing principle; according to this the total receipts of the great French railway systems must, in each year, cover all the establishment and working charges of the systems. These charges include in particular the payment of interest on the Company's bonds and the provision of the dividend on shares, including as additional to the minimum dividends fixed by previous agreements, a bonus calculated on increase of receipts and on the improvement in industrial production. In place of a payment that was independent of results, and had been created by the guaranteeing of interest, even before the war in the case of two railway systems [1], there was accordingly substituted a method of working for all the systems dependent on the results of them all. These have been given identical financial interests and extended credit that will permit of the rapid development and improvement of the national equipment, and afford relief to the national budget.

The financial community of interests of the several railway systems is the result of the pooling principle on which the new agreement is founded, a principle which involves the payment by the more remunerative railway systems of their surpluses to cover the deficits of the other railway systems.

At the same time a common higher organization will facilitate the unification of working conditions under the stronger control of the Minister of Public Works.

Finally, as against the new financial arrangements, the systems have made important concessions to the State, notably in respect to terms of purchase.

[1] The Midi and Paris-Orléans Railways.

Such, briefly, are the general principles of the new régime for the railways.

Law of 29 October 1921.

ARTICLE 1. — Approval is given to the agreement made the 18 June 1921 between the Minister of Public Works, the Northern, Eastern, Paris-Lyons-Mediterranean, Paris-Orleans and Midi Railway Companies, the Syndicates of the « Grande » and the « Petite-Ceinture » Railways and the Administration of the State Railways, for the working of their systems.

A copy of the said agreement will be scheduled to the present law.

ARTICLE 2. — Every year the Finance Act will fix provisionally :

1° the amount of the advances that the Treasury is authorized to make to the common funds in pursuance of clause 13 of the agreement before mentioned;

2° the total amount of bonds that each railway system is authorized to issue for any purpose whatever and in particular in pursuance of clauses 13, 16 and 25 of the agreement before mentioned.

ARTICLE 3. — For each railway system there shall be formed a co-operative commercial association of the employees of the system. The articles of association shall be approved by an Order in Council made on the recommendation of the Minister of Public Works. The Board of Management shall be composed exclusively of servants engaged in the service of the system.

Each servant of a system may pay one half of the share of the bonus accruing to him as an employee of the system to the co-operative association, which shall invest all the funds (capital and interest) at its disposal :

either in shares of its railway system, provided that such investment in shares shall not exceed in each year one-fourth of the capital invested or in the aggre-

gate one-fourth of the capital of the railway system;

or in bonds of the great railway systems, or in State loans, or in bonds issued by or guaranteed by the State;

or in land or house property reserved for the occupation of servants of the railway system or in mortgages raised for building or for purchasing such property.

All personal securities shall be bought or sold through the Minister of Finance; they must be inscribed and registered in the name of the co-operative association.

Nevertheless, shares in the railway system may be registered either in the name of individual members of the association who may wish to acquire them on the above terms, or in the name of the association, provided always that the total of the shares purchased shall not exceed the maximum fixed in the third paragraph of the present clause.

An account shall be opened for each servant of the railway system belonging to the association, to which shall be carried one half of the successive bonuses accruing to him with the corresponding annual interest. He shall be entitled to invest one-fourth of the sums standing to the credit of his account in shares in his railway system. These shall remain in the keeping of the association. When the servant retires from it or leaves the service of the system, he shall receive his shares and also the balance of the amounts to the credit of his account either in a lump sum or in the form of an annuity.

The servant may also, at any time, devote all or part of the sum or shares standing to his credit to any social provident or insurance schemes founded by associations of railway servants and recognised as being of public benefit.

On the death of an employee while in service all amounts to the credit of his account shall revert to his legal representatives.

In the event of a great railway company, modifying its present financial constitution so as to create labour shares, pursuant to the law of 26 April 1917, the co-operative association of its servants, formed pursuant to the said law, should be substituted for the co-operative association of the railway system created pursuant to the first paragraph of the present clause.

The conditions of such substitution shall be determined by the administrative regulation provided under clause 14 of the agreement scheduled to the present Act.

The same decree shall set up for each railway system, including that of the State railways, an independent bank which may receive the second half of the share of the bonus accruing to the employees as well as all or so much of the first half of the bonus as the employee shall not have paid to the co-operative association; this bank shall be conducted by the employees under the same conditions as the association referred to in the first paragraph of this clause. The decree referred to above shall establish a Savings banking system by which the bank may either in the name and at the request of the employees and with such sums as may become payable to them acquire shares in their railway system, or railway bonds, or securities issued or guaranteed by the State, or may make payments to social insurance and provident schemes. Securities bought in the name of employees shall be handed over to them. Employees may moreover at any time withdraw the whole or a part of the sums standing to the credit of their account.

Article 4. — In the application of clauses 5 and 17 of the agreement before mentioned, the Minister of Public Works is authorized to delegate to the « Conseil supérieur » (1) the power of decision vested in him in cases specified by de-

(1) See Section I, article 2 of this Act, p. 1327.

crees made by the Council of Ministers on his recommendation.

Article 5. — The Minister of Public Works is authorized under the conditions of clause 17 of the agreement before mentioned to confirm rates and fares higher than the maxima fixed by clause 42 of the schedule of charges, to decrease the weight of free baggage specified in clause 44, to modify the limits provided in clause 46 for the carriage of unbroken loads, subject to the conditions hereinafter provided in clause 13, to increase the rates fixed under clause 56 (5°) for the carriage of letters and telegrams by special delivery, to increase the prices provided in clause 57 for the conveyance of prisoners, accused or convicted, and to increase the rates provided in clause 62 for supplies and dispatch of rolling stock over branch lines.

Article 6. — The representatives of the employees on the « Conseil supérieur » shall be elected; they must include six representatives of middle-grade employees and six of the lower grades.

Article 7. — Every employee, whether a manual worker or otherwise, who has to travel daily from his place of residence to his place of work and back shall receive special season tickets over routes to be fixed by the Minister of Public Works, to be called workmen's season tickets, available by third class, or by second class on lines not having a third class.

Article 8. — In families having three or more children under 18 years of age, at the request of the head of the family, the father, the mother and each of the children under eighteen years of age shall receive a strictly personal identification card entitling them to a reduction of fares of :

30 % for families with 3 children;
40 % for families with 4 children;
50 % for families with 5 children;
60 % for families with 6 children;
70 % for families with 7 children and upwards.

Such reduction is to be allowed on ordinary single and return tickets.

Article 9. — Ex-soldiers having a grade of incapacity reckoned as over 25 % are entitled to a reduction on the passenger fares.

This reduction will be 50 % for men having a grade of incapacity reckoned as 25 to 50 % and will be 75 % for still greater degrees of incapacity.

These privilege tickets shall moreover be issued to the guide of a completely disabled man, who is entitled to the benefit under the provisions of clause 10 of the Act of 31 March 1919.

These allowances apply to ordinary, single and return tickets.

Article 10. — At their request and on the certificate of the Mayor of the town in which they live, the Companies and the State railways system shall grant a second-class ticket each year to the widows, parents, grandparents, children and grandchildren of soldiers who died for the country and failing such relatives to the eldest brother or sister, who may transfer the benefit of their right to one of the other brothers or sisters in their stead, such ticket to entitle the holder to one free journey from his or her home to the place of burial of the relative by the military authority.

The relatives, the widow, the parents, grandparents, children and grandchildren of missing soldiers shall have the same privilege, entitling them to travel to the military place of burial nearest to the place indicated in the certificate of death.

Article 11. — The classes of persons other than servants and inspectors of the system who alone shall have the benefit of facilities for travelling at rates below the authorized fares shall be defined by an Order in Council made, after the

« Conseil supérieur » has been heard, on the recommendation of the Minister of Public Works.

ARTICLE 12. — Every collective dispute arising between the employees and one or more railway systems, particularly on questions relating to the Act or to the rules of work and pay or to superannuation arrangements shall be decided by an Arbitration Court to be constituted as follows : two arbitrators shall be nominated by the representatives of the railway systems on the « Conseil supérieur », two arbitrators shall be nominated by the representatives on the « Conseil supérieur » of the servants belonging to the class or classes of servants interested in the dispute; a fifth arbitrator or umpire who, ex officio, shall be the president of the Court, shall be nominated by the « Conseil supérieur », sitting without the representatives of the systems and of their servants. This fifth arbitrator or umpire shall nôt be a member of the « Conseil supérieur ».

ARTICLE 13. — Within six months from the establishment of the « Conseil supérieur » of the railways an agreement shall be made between the railway systems, the Minister of Public Works and the Administration of the Post Office to provide for the conveyance of what the Post Office may have to send by railway and to define the conditions and periods to be allowed for the conveyance of postal packages.

An agreement between the railway systems, the Minister of Public Works and the Prisons Board shall provide similarly for the conveyance of what the Board may have to send by railway.

These agreements shall not come into operation until they have been confirmed by special laws.

ARTICLE 14. — Within three months from the date when this Act comes into force the large public railway systems shall submit bye-laws supplementary to their superannuation regulations for confirmation by the Minister of Public Works.

These bye-laws shall be such that servants of the same railway system receiving the same pensions and of the same occupations who were superannuated before the 1 January 1919 with immediate pension rights shall receive equal increases.

The said provisions shall grant to servants superannuated after 1 January 1919, with immediate pension rights, that is before they had enjoyed for six years the benefit of the scales of salary at present in operation, such complementary pension allowances as will make good the differences between the pensions calculated on the basis of the old salaries, increased under the provisions of the last paragraph of this clause, and the pensions calculated on the basis of the new salaries.

ARTICLE 15. — Registration of the agreement scheduled to the present Act shall require the payment only of the fixed duty of three francs (3 fr.).

AGREEMENT

made the 28th day of June one thousand nine hundred and twenty-one.

Between :

The Minister of Public Works acting on behalf of the Government subject to the adoption of these presents in a law, of the one part;

And of the other part :

The Managing Body of the State Railways, represented by Mr. DEJEAN, director of the State Railways;

The limited Company established in Paris under the style of « Compagnie des chemins de fer de l'Est » (Eastern Railway), represented by Messrs. GOMEL, the president of the Board of Directors and baron DAVILLIER, vice-president, whose address for legal service is the registered office of the said Company in the Rue and Place de Strasbourg, Paris, acting

under powers conferred on them by a resolution of the Board on 12 May 1920, and subject to the approval of these presents by a general meeting of shareholders;

The Limited Company established in Paris under the style of « Compagnie du chemin de fer du Nord » (Northern Railway), represented by Messrs. baron Edouard DE ROTHSCHILD, president of the Board of Directors, GRIOLET, vice-president, and VALLON, a Director, whose address for legal service is the registered office of the said Company, 18, Rue de Dunkerque, Paris, acting under powers conferred on them by a resolution of the Board on 14 May 1920, and subject to the approval of these presents by a general meeting of shareholders;

The Limited Company established in Paris under the style of « Compagnie des chemins de fer de Paris à Lyon et à la Méditerrannée » (Paris-Lyons-Mediterranean Railway), represented by baron GIROD DE L'AIN, a Director, whose address for legal service is the registered office of the said Company, Rue Saint-Lazare, 88, Paris, acting under powers conferred on him by a resolution of the Board on 14 May 1920, and subject to the approval of these presents by a general meeting of shareholders;

The Limited Company established in Paris under the style of « Compagnie du chemin de fer de Paris à Orléans » (Paris-Orleans Railway), represented by Mr. VERGÉ, president of the Board of Directors, whose address for legal service is the registered office of the said Company in Paris, acting under powers conferred on him by a resolution of the Board on 14 May 1920, and subject to the approval of these presents by a general meeting of shareholders;

The Limited Company established in Paris under the style of « Compagnie des chemins de fer du Midi » (Midi Railway), represented by Mr. George TEISSIER, president of the Board of Directors, whose address for legal service is the registered office of the said Company, 54, Boulevard Hausmann, Paris, acting under powers conferred on him by a resolution of the Board on 14 May 1920, and subject to the approval of these presents by a general meeting of shareholders;

The « Syndicat du chemin de fer de Grande-Ceinture de Paris », represented by baron Edouard DE ROTHSCHILD, vice-president, whose address for legal service is the registered office of the Syndicate, 16, Rue de Londres, Paris, acting under powers conferred on him by a resolution of the Syndicate on 12 May 1920, and subject to the approval of these presents by a general meeting of the Syndicate;

The « Syndicat du chemin de fer de Petite-Ceinture de Paris », represented by Mr. GOMEL, president, whose address for legal service is the registered office of the Syndicate, 16, Rue de Londres, Paris, acting under powers conferred on him by a resolution of the Syndicate on 12 May 1920, and subject to the approval of these presents by a general meeting of the Syndicate;

It has been agreed as follows :

SECTION I.

General provisions.

ARTICLE 1. — From 1 January 1921 the working of each of the railway systems, concessions for which are held respectively by the Eastern, Midi, Paris-Orleans, Northern and Paris-Lyons-Mediterranean Companies and of the railway system managed by the Administration of the State Railways shall be subject to the hereinafter mentioned provisions, which include, subject to the supreme authority of the Minister of Public Works :

1° a common organization for ensuring the co-ordination of the working of the several railway systems in accordance with the general interests of the nation;

2° the co-operation of the railway systems with each other and with the

State and common financial interests so as to ensure the establishment and maintenance of a balance between expenses of every description and the traffic receipts.

Article 2. — The organization common to all the railway systems is composed of a « Conseil supérieur des chemins de fer » (styled briefly the « Conseil supérieur » and hereinafter in this translation called the Council) and a Managing Committee, of which the composition, powers and working conditions are hereinafter defined.

In addition to this common organization each railway system retains its internal organization and its individual working.

Article 3. — The council is composed of a president and :

a) eighteen members of the Managing Committee;

b) for each of the six railway systems two representatives of the servants, appointed by the Minister of Public Works;

c) thirty members representing the general interests of the nation, appointed by decrees made on the recommendation of the Minister of Public Works.

The president is appointed by a decree made on the recommendation of the Minister of Public Works.

Any member ceasing to hold the office to which he was appointed ceases absolutely to be a member of the Council; he is to be immediately replaced by a new member, nominated under the same conditions as was the member whom he replaces.

The director of railways at the Ministry of Public Works sits on the Council as Government Commissioner.

The details of the organization and working of the Council shall be fixed by an Order in Council, made on the recommendation of the Minister of Public Works; this order shall define particularly the conditions under which members of the Council and the Government Commissioner can cause their places to be filled when they are prevented from acting.

Article 4. — The Council is required by the Minister of Public Works to consider questions of common interest to all the railway systems relating to technical, commercial, administrative and financial matters.

The Council shall also advise on such important questions affecting one or more railway systems as the Minister may think desirable to refer to it.

In particular the following questions come within the jurisdiction of the Council :

concessions for new lines;

modifications in the constitution of railway systems;

measures relating to the modification of the financial administration of the railway systems;

programmes of additional works;

programmes of electrification;

programmes for connecting railway systems with each other, and with ports, waterways, and any other ways of communication;

programmes for acquiring rolling stock and means of securing standardization in plant and of deciding the total stock required:

general working regulations and standard methods of signalling;

general measures relating to the police, and the safety and use of railways;

periodical modifications of train services;

rates and fares, as well as their uniform application on all systems, and their revision so as to ensure a balance of the aggregate receipts with the aggregate expenditure as hereinafter provided in clause 17;

agreements with « foreign » railways for making new railroad junctions and sharing traffic, as well as periodical

modifications of the time-tables of the international through trains;

authorizations for issue of bonds.

The Council is further required to consider, in accordance with the provisions of the Act by which this agreement is approved, questions relating to by-laws, rules regarding work and pay, and superannuation societies for the staff.

ARTICLE 5. — Resolutions of the Council shall be taken by a majority of votes of members present, or, in case of equality, by the casting vote of the president.

Resolutions of the Council on matters within the jurisdiction of the Minister of Public Works under the Act, and the agreement and regulations for the time being in force shall be submitted for approval to the Minister of Public Works. Nevertheless, in matters relating to questions for which the Council has been invested specially with the powers of the Minister, such resolutions shall have full executory force if the Minister does not intimate his objection within one month.

The Minister can only give a decision contrary to a resolution of the Council after the Council has considered the matter a second time.

Within one month from the receipt of a resolution of the Council or a decision of the Minister, the Managing Committee may require the Council to reconsider the subject of such resolution or decision, if it is of opinion that the resolution or decision is contrary to the interests entrusted to the Council. The Government Commissioner may likewise require the Council to reconsider a resolution whenever he thinks it necessary.

Should the Council fail to arrive at a decision within the time fixed by the Minister for the Council's reply to the reference, the Minister shall decide the matter after formal notice to the Council.

Should a railway system fail to obey a decision of the Minister given as provided in this clause, the Minister shall give formal notice to such system, and the prescribed measures may then be officially carried out at the expense of the system and subject to the conditions expressed in the notice.

ARTICLE 6. — The Managing Committee shall consist of two directors of each of the five Companies referred to in the first clause hereof, nominated by the Board of the Company, and of each Company's general manager, and of the general manager, president and vice-president of the Managing Body of the State railway system. The Committee chooses its own president and vice-president from amongst its members.

Members of the Managing Committee may provide for substitutes in the event of their being themselves prevented from discharging their duties.

The Director of railways at the Ministry of Public Works, or his deputy sits on the Managing Committee as Government Commissioner.

ARTICLE 7. — The Managing Committee shall deal with all questions affecting the whole of the systems and in particular with :

a) measures for assuring technical coordination of the railway systems with each other and close and constant cooperation between their services;

b) rates and fares; — technical regulations for working and for signals; — patterns of fixed plant and rolling stock; — rules for apportioning traffic and dividing receipts; — general conditions relating to the exchange of rolling stock;

c) modifications of by-laws, and of regulations relating to work, pay, and superannuation societies;

d) general rules relating to the granting of traffic facilities;

e) general working conditions affecting the two Ceinture railways.

ARTICLE 8. — The agenda of meetings

of the Managing Committee shall be sent in good time to the Government Commissioner and to each of the railway systems.

Resolutions shall be passed by a majority of votes, each system having only one vote; in case of equality the decision shall be given by the railway system whose president or vice-president is acting as chairman at the meeting.

The Government Commissioner has power to place any question that he thinks desirable on the agenda, and he is empowered to call a meeting of the Committee to consider it. He has also the right to require a question to be reconsidered if this should appear to him to be necessary.

Resolutions of the Committee are binding on all the railway systems.

If a railway system considers its interests to be adversely affected in respect of rates and fares, or of allocation of traffic, or of exchange of plant or rolling stock as the financial consequence of resolutions adopted by the Managing Committee in pursuance of clause 7 hereof and of the present clause, it may demand an allowance from the other systems concerned. The allocation of such allowance shall, if necessary, be decided by arbitration.

ARTICLE 9. — The Minister may, at all times, with the approval of the Council of Ministers require a reduction in special rates or fares if their level appears to him injurious to national interests. Before using this right the Minister shall invite the railway system or systems affected to submit proposed reductions for his approval, and, in the event of this invitation not being accepted, he shall require the opinion of the Council. If the Council is of the opinion that a reduction is justified it shall, in place of the railway system or systems affected, prepare proposals for the approval of the Minister. With the concurrence of the Ministerial Council, the Minister may himself prescribe the reduction, even after a second adverse resolution of the Council.

ARTICLE 10. — From the date when the new régime comes into operation :

1° no transfer of a line from one of the participating railway systems to another shall be made without the approval of the Council;

2° no line the concession for which has not yet been granted shall be made without the approval of the Council.

The railway systems further undertake to accept on the terms of the present agreement such concessions as may be made to them in excess of the maximums provided in previous agreements, up to

500 km. (310 miles) for the State railway system;

180 km. (112 miles) for the Eastern railway system;

150 km. (93 miles) for the Midi railway system;

300 km. (186 miles) for the Paris-Orleans railway system;

100 km. (62 miles) for the Northern railway system;

500 km. (310 miles) for the Paris Lyons-Mediterranean railway system;

the concession to be specified by the Minister after hearing the railway system concerned.

In default of special agreement new lines shall be constructed at the expense of the State as to four-fifths of the cost and of the railway system concerned as to the remaining fifth. Where a railway system has undertaken the construction of a new line and the final cost exceeds the estimate submitted to and approved by the Minister of Public Works, such system shall carry half the excess to its capital account, except in the case of « force majeure » duly proved.

All subventions that may be granted by Departments, Communes or private individuals shall be deducted from the share of expenditure to be borne by the State.

The State may require the railway system to advance to it the funds required for the construction of the line. In such case the State shall repay to the system the actual cost of any loans it may effect for the purpose of such advance. The annual payment shall include interest, sinking fund, loan expenses, stamp and other duties chargeable to the system to which the bonds are or hereafter may be allotted.

Until 1 January next following upon the complete opening of a line for service the actual amount expended by the railway system together with the working expenses shall be paid out of the receipts from the working of the said line, or, if they should exceed such receipts, carried to capital account.

All the provisions of this clause shall be applicable to the concession and construction of the mileage still available on the figures of the agreements of 1883.

Article 11. — Each railway system shall present, before the 1 November of each year, the programme of additional works which will be undertaken by it and which it expects to execute during the following year; this programme may be modified during the financial year.

The Council will examine such programme with the object of determining whether it meets the needs of the service and will submit to the Minister a report in justification of the subject.

If the programme submitted by a railway system is considered insufficient, excessive or premature, and if the system and the Council cannot come to agreement, the Council shall submit its proposals to the Minister.

Article 12. — When, in pursuance of powers conferred on him by the laws and regulations for providing against the inadequate equipment of a railway system, of its staff, or of its plant and stock in view of needs that have already arisen or are to be anticipated by reason of increase of traffic, the Minister has to give a decision, he shall call for the opinion of the Council, if it has not already come to a conclusion on the matter, before giving formal notice to the Administration concerned.

SECTION II.

Financial provisions.

Article 13. — A common fund is hereby created for the purpose of promoting the community of financial interests between the great railway systems, of making provision for pooling their receipts with their expenses, and of making them, when necessary, such advances during the financial year as may be necessary for current expenditure.

A special account shall be opened for this common fund in the books of the Treasury, which shall be put in credit by the surplus receipts of the railway systems as hereinafter provided in clause 15.

If this surplus is inadequate an increase of rates and fares shall be made on the conditions hereinafter provided under clause 17. In case of need advances shall be made to the common fund by the Treasury, and these shall be repaid as provided in the said clause. If, and whenever the Minister of Public Works shall so require, the railway systems shall issue bonds to cover all or part of the advances to be made to the common fund, the State guaranteeing interest, sinking fund and actual expenses of such securities, until paid off by it.

The balance of the common fund shall become the property of the State when all the railway systems have reverted to the State.

Article 14. — Each railway system and its servants shall be allowed annual bonuses with the object of interesting them in developing traffic and economising expenses.

The bonus of the system shall be composed of two independent parts :

a) 3 % of the excess of receipts during the financial year over and above those of 1920 (exclusive of so much of the current surplus as may have arisen from increases made on the basic rates or fares). When this excess is more than 20 % of the receipts of 1920 the bonus on the surplus shall be reduced to 2 %;

b) 1 % of the reduction on the figure in the accounts for 1920 for the deficiency of receipts below expenses, or, if the receipts exceed the expenses, 1 % of the total of such excess and of the deficit for 1920.

In and after the financial year next following that in which receipts and expenditure have balanced, that is to say, in which the aggregate receipts of the systems shall be not less than the aggregate outgoings hereinafter set forth in clause 15, the bonus calculated in pursuance of the last clause hereof shall be increased by 1 % on the amount by which the deficit shall have been reduced below, or the surplus have been increased above, the figures of the year when receipts and expenditure balanced.

For the Eastern and Northern railway systems the coefficient of 1 %, which appears in the first paragraph of the bonus B shall be raised to 2 % for the years 1921 to 1924 inclusive; this increase of 1 % shall thereafter be reduced annually by a tenth part, and will disappear from the year 1934 onwards.

The receipts referred to in the last three paragraphs include so much as may be due to increases of rates and fares. The expenses are the total : 1° of the expenses hereinafter referred to in paragraphs *a*) and *c*) of clause 15 (after deducting, in the case of the great railway systems, the financial results of the Ceinture lines); 2° of one-half of the charges defined in paragraphs *b*) and *d*) of the said clause; 3° after the end of the financial year of 1922, of the bonuses paid both to the system and to its servants for the previous financial year.

Nevertheless for the financial years 1921 to 1926 inclusive there shall be deducted from the working expenses of 1920 one-half of the difference between the cost of fuel for haulage of trains during 1920 and the corresponding expenditure for 1921.

For the financial years 1927 and onwards there shall be deducted from the working expenses of 1920 the entire difference between the cost of fuel for haulage of trains during 1920 and the corresponding expenditure for 1927. In the case of lines electrified after 1 January 1921 the corresponding expense for 1927 shall be calculated in accordance with the train-kilometres run by the electric trains, the average consumption per kilometre of the steam trains, and the average price of coal for the system in question.

If, as compared with the results of the financial year 1920, the deficit of receipts below expenditure calculated as hereinbefore provided shall have increased, a penalty of 2 % of such increase shall be deducted from the bonus B of the next financial year, and if necessary of subsequent financial years until it has been completely extinguished.

If the total bonuses A and B payable to the railway system in pursuance of the preceding paragraphs exceed one-third of the sum hereinafter fixed in paragraph *d*) of clause 15, one-half of such excess shall be paid to the common fund; if, after such payment, it shall exceed two-thirds of the said sum, then two-thirds of such new excess shall be paid into the common fund.

The bonus to be paid to the whole of the servants of each railway system shall be composed of two independent parts A and B calculated as herebefore provided, but without taking account of the contingent payments to the common fund as provided in the preceding paragraph.

The parts A and B shall be doubled until such time as the total bonus payable

to the servants of the railway system amounts to 1.50 % of the receipts for the financial years under consideration on which the part A of the bonus is calculated. From this point the bonus to servants shall be increased by the addition of the surplus of the parts A and B not doubled.

The amount of the bonus shall be fixed each year by the Ministry of Public Works on the recommendation of the railway systems after receiving the report of the Audit Commission.

The bases of distribution of the part of the bonus payable to the servants of the railway systems shall be determined by an Order in Council made on the recommendation of the Minister of Finance after receiving the report of the Council.

ARTICLE 15. — Of the gross receipts of every kind appearing on its working account each system shall take :

a) its working expenses as defined by the agreements in force;

b) the amount of the actual charges (interest, sinking funds, incidental expenses, etc.), of its subscribed capital and of loans of every kind that it has contracted or taken over, after deducting repayments and annuities due by the State, Departments, Communes and private individuals and, so far as concerns the Northern and the Paris-Lyons-Mediterranean systems, the annuities for repayment as hereinafter provided in clause 19, it being understood that in and after the financial year 1927 the charges with respect to bonds issued to cover all or part of the advances made to the common fund during the years 1921 to 1926 inclusive shall be taken from the common fund without being brought into account in the calculation of bonuses.

The State railway system shall take :

on the one hand a sum of 35 685 000 fr., representing the charges incurred by the old State railway system during the period up to the purchase of the Western railway system;

and on the other hand the net charges as provided by the law of 13 July 1911 after deducting :

1° a sum of 19 361 000 fr., the amount of the annuity payable by the State as its share in the construction of the lines of the old system;

2° a sum of 6 300 000 fr. included in the sum of 8 300 000 fr. shown under *d*);

c) the deficits on joint financial enterprises and the workings connected therewith, royalties, repayments, annuities and all other charges payable by the system;

d) a sum of :

8 300 000 fr. for the State railway system;

9 052 000 fr. for the Eastern railway system;

6 250 000 fr. for the Midi railway system;

24 600 000 fr. for the Paris-Orleans railway system;

20 000 000 fr. for the Northern railway system;

28 000 000 fr. for the Paris-Lyons-Mediterranean railway system.

e) the bonus hereinbefore provided in clause 14.

The surplus, if any, shall be paid into the common fund; if the receipts do not cover the aggregate amounts above specified, the difference shall be paid to the system out of the common fund.

ARTICLE 16. — The expenses to be borne by the State or by the railway systems for the construction of new lines, as well as for the execution of additional works, increase and renewal of plant, equipment of the permanent way and shops, equipment of stations, stores, etc., shall be covered by new bonds with a sinking fund not exceeding sixty years. The bonds shall have leaves of coupons each covering a period of twenty years. The period of the sinking fund shall be graduated for each leaf from sixty years for bonds

issued in the first year to forty years for bonds issued in the twentieth.

These bonds shall be issued by each railway system for its own benefit, with the approval of the Minister of Public Works on the report of the Council and of the Minister of Finance. The securities shall be of uniform pattern for all the railway systems, but shall bear the name of the system by which they are issued.

The sums payable under these new bonds shall be guaranteed for the duration of the concession granted to the railway system by the payments provided in paragraph *b)* of clause 15, and, if these sums are insufficient, by the common fund; at the termination of the concession these sums shall be paid by the State.

ARTICLE 17. — During the first six years after the new régime has come into force, the rates and fares shall, if necessary, be revised by decisions of the Minister of Public Works on the recommendation of the Council, even above the maximums provided in the schedules of charges, to such extent as may be required for balancing receipts, on the one hand with expenses (exclusive of shares of bonuses payable to the Companies and the Administration of the French State railways) and on the other hand with the charges.

Such revision can only be made within the limits compatible with the general economic situation.

The Council shall, if necessary, present its first proposals for revision within three months from its coming into office.

At a later date, if the payments from the common fund shall exceed its receipts, the Council shall propose to the Minister of Public Works that he shall decide, subject to the above conditions, the increases of rates and fares necessary to :

1° re-establish a balance between the annual payments out of and into the common fund;

2° make good the previous deficit so that at the end of two years at the most, the common fund will have repaid to the Treasury all advances relating to the financial years 1927 and onwards;

3° ensure from 1927 onwards the repayment to the Treasury of the charges that have to be continued for the service of the bonds issued by the railway systems from 1921 to 1926, the six first charges on these bonds remaining to be borne wholly by the State in pursuance of paragraph 3 of clause 13 herebefore set forth.

Increases of rates and fares proposed by the Council shall come into force without further authority if the Minister of Public Works after consultation with the Minister of Finance does not signify opposition to them within one month.

Nevertheless if, from 1 January 1921 to 31 December 1926, the said increases exceed the maximums of the schedule of rates by more than 180 % for goods or more than 100 % for passengers, they shall be applicable as a temporary measure subject to the conditions above provided, but shall be submitted for the ratification of Parliament.

The limits of 180 % and 100 % may be replaced by other limits for a period of five years, to be submitted to Parliament after it meets in January 1926, and agreed by the Minister of Public Works on the advice of the Council; the new limits shall come into force not earlier than six months after the date of the law approving them, which date shall not be earlier than 1 January 1927, the previous limits being accordingly prolonged. The same procedure shall be adopted every five years until the end of the concession.

The preceding provisions shall not invalidate such partial rearrangements of rates and fares as may be considered desirable and may be proposed by the railway systems or requested by the Minister according to the usual procedure.

ARTICLE 18. — When the receipts of the common fund, after repayment of the advances made to it by the Treasury shall exceed its outgoings, the excess shall be carried to a reserve up to a maximum to

be determined by the Minister of Public Works on the recommendation of the Council, after consultation with the Minister of Finance. When on 31 December of any year the excess received by the common fund over its outgoings shall exceed the maximum reserve, such surplus shall belong to the State.

When the common fund shall have paid surpluses to the Treasury the Minister may, after communication with the Council, lower all or part of the rates and fares so as to balance as nearly as possible the receipts of the common fund with the charges it has to bear.

Article 19. — Debts due under guarantee from the financial years prior to 1914 shall be ascertained as at 31 December 1913; they shall cease to bear interest as from that date, except in the case hereinafter provided in the last paragraph but one of clause 21; they shall become due only at the end of the concession or in case of purchase.

The State relieves the Companies of the debts they have contracted by way of guarantee of interest for the years 1914 and onwards until the new régime comes into force.

It will repay the Northern and the Paris-Lyons-Mediterranean Companies by annuities, payable until the end of their concessions, and, pursuant to clause 15*b*, the sums carried or to be carried to the capital accounts of these two railway systems in accordance with clause 20 of the law of 26 December 1914, and not covered by transfers or repayments.

Article 20. — When the railway systems of two of the Companies that are parties to this agreement shall have reverted to the State, either by purchase, or at the end of their concessions, each of the other Companies may, within three months of the disappearance of the second Company, require to be purchased on the conditions hereinafter mentioned in clause 21. The purchase shall take effect from 1 January next following the end of the said period of three months.

The Companies that avail themselves of the provisions of the last paragraph shall, on so doing, renounce the right to repayment of expenditure on additional works and new lines provided by the agreement of 1883. The Companies shall also renounce the right to repayment of the cost of stores, of which the purchase is covered either by bonds or by short-term notes, of which the State as from the date of the purchase will pay the interest and guarantee the repayment, or by other Treasury methods of which the State will assume the burden.

If after the normal expiration of the concessions of the Northern and Eastern Companies the other Companies claim the benefit of the provisions of the present clause, the State may, for the latter Companies, defer till the normal date of expiration of their concessions the payment for taking over the equipment at the value defined in clause 36 of the schedule of charges.

Article 21. — In the event of the purchase of a railway system the purchase price shall be calculated as provided in the schedule of charges and the agreements in force.

In determining the net proceeds of working, account shall not be taken of the results of the years 1914 and onwards until 31 December 1920.

The purchase price shall be settled as at the end of one year and the system shall be taken over on the 1 January following.

In determining the net proceeds payments made to the railway systems from the common fund shall be included in the working receipts, and in the expenses those made by the Company to the common fund, in accordance with clause 15.

Account shall not be taken in the purchase money either of the share of bonus payable to servants of the railway system or of the charges representing the re-

payment of war deficits to the Northern and Paris-Lyons-Mediterranean Companies.

To the purchase money shall be added the difference between the charges for a complete year on the capital that the Company may expend during the last year and the expenses incurred during such last year with respect to the same capital.

In all cases of purchase, and on the expiration of the concession of a railway system, the State shall take over the superannuation, insurance, benevolent, special pension and supplementary pension funds as at the date of such purchase or expiration with all the rights and obligations of the Company with respect thereto.

Equipments acquired during the war with the assistance of the State shall only be debited to the inventory at the amounts actually disbursed by the Companies.

Within the two months following the approval of the present agreement, the Companies shall take over formal possession of the rolling-stock and equipment delivered to them under the terms of the Armistice or the Treaty of Peace. All these assets, included retrospectively in the inventory as at the dates at which they were in fact delivered to the railway systems, shall be taken in such inventory at their actual value when delivered by the Germans as fixed by the Reparations Commission. The railway systems shall pay such value to the State, less the value of such material as may be allotted to them as compensation in kind for the value of a portion of the stock and equipment that disappeared during the hostilities.

Supplies from the American stock (Pershing) shall be entered retrospectively, as at 3 October 1918, and shall be taken over and paid for by the railway systems at the value at which they were transferred by the State.

Material from the American depôts (Felton and Slade) shall be debited to the inventory at the actual dates of its delivery on rail. It shall be taken over and paid for by the railway systems at its actual cost price.

On its purchase or on the expiration of its concession the sum to be paid to a railway system for the purchase of equipment as defined in clause 36 of the schedule of charges shall be determined as follows :

The price, at which the said articles with the exception of stores shall be taken over, shall be ascertained as for a contract from the sums debited each year to the inventory with the addition of their proportional share of overhead charges and current interest, less a fortieth part for each completed year dating from 31 December of the year in which the debit was made. If, with the approval of the Minister, all or part of the value of any steamboat property has been carried to capital account, it shall be treated in all respects as if it were rolling-stock with the sole exception that, in lieu of the reduction of one-fortieth last mentioned a reduction shall be made of one-twentieth. In the contract calculation only such articles shall be included as may be in existence at the date of purchase of the railway system or the expiration of the concession.

Nevertheless in the case of all articles acquired by means of new bonds, as before provided in clause 16, and in the case of stores covered by similar bonds the purchase price ascertained as before described shall be reduced by as many fiftieths as the number of years that will elapse between the year in which the cost was covered by bonds and the end of the concession.

Any articles on which the above named reductions would equal or exceed their inventory value and which the Minister desires to purchase shall be taken over at scrap value.

The price at which stores shall be taken over shall be the actual cost price.

The reduction provided in the fourteenth paragraph of this clause shall apply

to such additional works executed from and after 1 January 1921 as are to be purchased in pursuance of earlier agreements.

Should the State purchase a railway system before the expiration of the period of seven consecutive years from 1 January 1921 the equipment of such system on 1 January 1914, or then in the course of construction, shall be taken over as if by contract at the sums at which they were debited to the inventory, with the addition of their proportionate share of overhead charges and current interest, less an allowance of one-fourth for wear and tear. From the value of such property so ascertained shall be deducted the debt with respect to interest guaranteed to 31 December 1913, to which for this purpose shall be added simple interest from 1 January 1921 to the date of purchase.

In the event of purchase the Companies renounce their right to repayment of such complementary expenses as they may be authorized to incur after the present agreement comes into force for the construction of electrical generating stations and high-tension transmission lines for electric traction.

SECTION III.

Miscellaneous provisions.

Article 22. — All provisions of previous agreements not inconsistent with those of the present agreement are confirmed.

Article 23. — The Minister of Public Works may at any time decide that the Alsace-Lorraine railway system shall enter into the common organization and may be subject to the conditions of the present agreement, the financial provisions of which shall apply to it from 1 January preceding, or such date as may have been provided in the decision of the Minister. In such case the Managing Committee shall be increased by the addition of three representatives of the Alsace-Lorraine system and the Council shall be increased by the addition of these three representatives together with two representatives of the staff of the said system and five representatives of the public interest.

Article 24. — The Minister of Public Works shall apply the conditions of this agreement to whatever bodies may be substituted for one or more of the present railway systems.

Article 25. — The State renews the undertaking to restore parts of the railway systems that have been destroyed or damaged by the incidents of war to the same condition as that in which they were on 2 August 1914, in particular in respect of their rolling-stock, equipment and stores. It may require each system to advance all or part of the necessary sums; and, in such case, the State will repay to the system the actual charges incurred with respect to loans raised to cover such advances. All the railway systems undertake expressly to make no claim against the French State in respect of war damages of any kind whatever, and in particular with respect to the law laid down in the last paragraph of clause 3 of the Act dated 17 April 1919. They make over to the French State all rights to reparation which, under the peace treaty, they would have been entitled to formulate against Germany and her Allies, with the exception of damage done to their private estate.

Article 26. — Forthwith, on the approval of the present agreement, the State of the one part, and the Companies with the Administration of the French State Railways of the other part, will on both sides abandon any legal action, opposition or judicial claim for compensation or restitution in respect of war charges which they may have instituted between 1 August 1914 and the date of this Agreement. The Companies and the Adminis-

tration of the French State Railways will also abandon all claims with respect both to guarantee accounts and to the application of laws, decrees, ministerial decisions and agreements entered into between the State and the railway systems. They abandon accordingly all suits in progress, waive all claims, and will pay the costs incurred.

ARTICLE 27. — The annual working expenses of the Council, of the Managing Committee and of the Government Commissioner as defined by the administrative decrees will be borne by the railway systems in proportion to their gross receipts for the previous year.

ARTICLE 28. — The present agreement shall be registered on payment of the fixed duty of 3 fr.

The signatures follow.)

MISCELLANEOUS INFORMATION

[625 .242 (.73)]

1. — New 50-ton composite gondola cars for the Chicago, Milwaukee & St. Paul Railway.

Figs. 1 and 2. pp. 1339 and 1340.

(*From the Railway Review.*

In leasing the Chicago Terre Haute & Southeastern Railway, which handles the traffic of the coal fields of Indiana, the Chicago Milwaukee & St. Paul saw the coal traffic increased on its lines, both for company use and for the territory served by its lines.

In order to perform this transportation of coal, the Company ordered 2 500 composite gondola cars having 50 tons capacity, with steel framework and wooden body.

The objective of the designers was to build a car of capacity and design suitable for hauling coal and for general service, giving equal consideration to economy in construction and in maintenance. To obtain high serviceability. the endeavor was made to select logical sections and to obtain a disposition of metal proportionate with the static and dynamic stresses to be resisted. In designing the connections due regard was given to the provision of ample rivets, while omitting those not essential.

That considerable thought has been given to securing an efficient and economical design is evident when the strength, rigidity and a light weight of this car which is 40 400 lb. is contrasted with other designs. The underframe as well as the framework of the sides and ends of these cars are built up steel construction, the floor, sides and ends being lined with 2 1/4 inch shiplapped Douglas fir.

The built-up center sill construction, which is of constant depth for its entire length, is designed to transmit only the end forces due to pulling and buffing, the steel side framing being designed to carry all the load not coming directly upon the body bolsters. Two 15-inch 33.9 lb. channels extend from end sill to end sill, spaced 12 7/8 inches back to back with combined cast steel bolster separator and draft gear back stop.

On the inside of the center sill channels, two 3 1/2 by 3 by 5/16 inch bottom chords extend from the front face of the draft gear back stop casting to a similar point at the opposite end of the car. These bottom chord angles are connected with the center sill channels by means of rivets passing through the vertical leg of the angles and the web of the center sill channels. The two 15-inch channels are tied together at the top by a 20 by 1/4 inch continuous one-piece top cover plate which extends from end sill to end sill. This cover plate passes under the transverse cover plates, at the body bolsters and cross bearer diaphragms, and is riveted to the center sill flanges throughout its entire length. The center sills are also reinforced at their lower flange by the aid of two tie plates, located just ahead of the center plate, which are riveted to the bottom flanges of the channels. The channel center sills are additionally reinforced by five 1/4 inch pressed pan separators which are located at the deep and shallow crossbearers and extend full depth of the channels.

The side sills are 9 inch 13.4 lb. standard channels extending from end sill to end sill, riveted to the body bolster and small and large cross bearer diaphragm pans. The end sills are 4 by 6 by 3/8 inch standard angles, extending full width of the car, passing over the center sill top cover plate and side sill channels, and having the long leg in contact with and riveted to these members. The side sills and

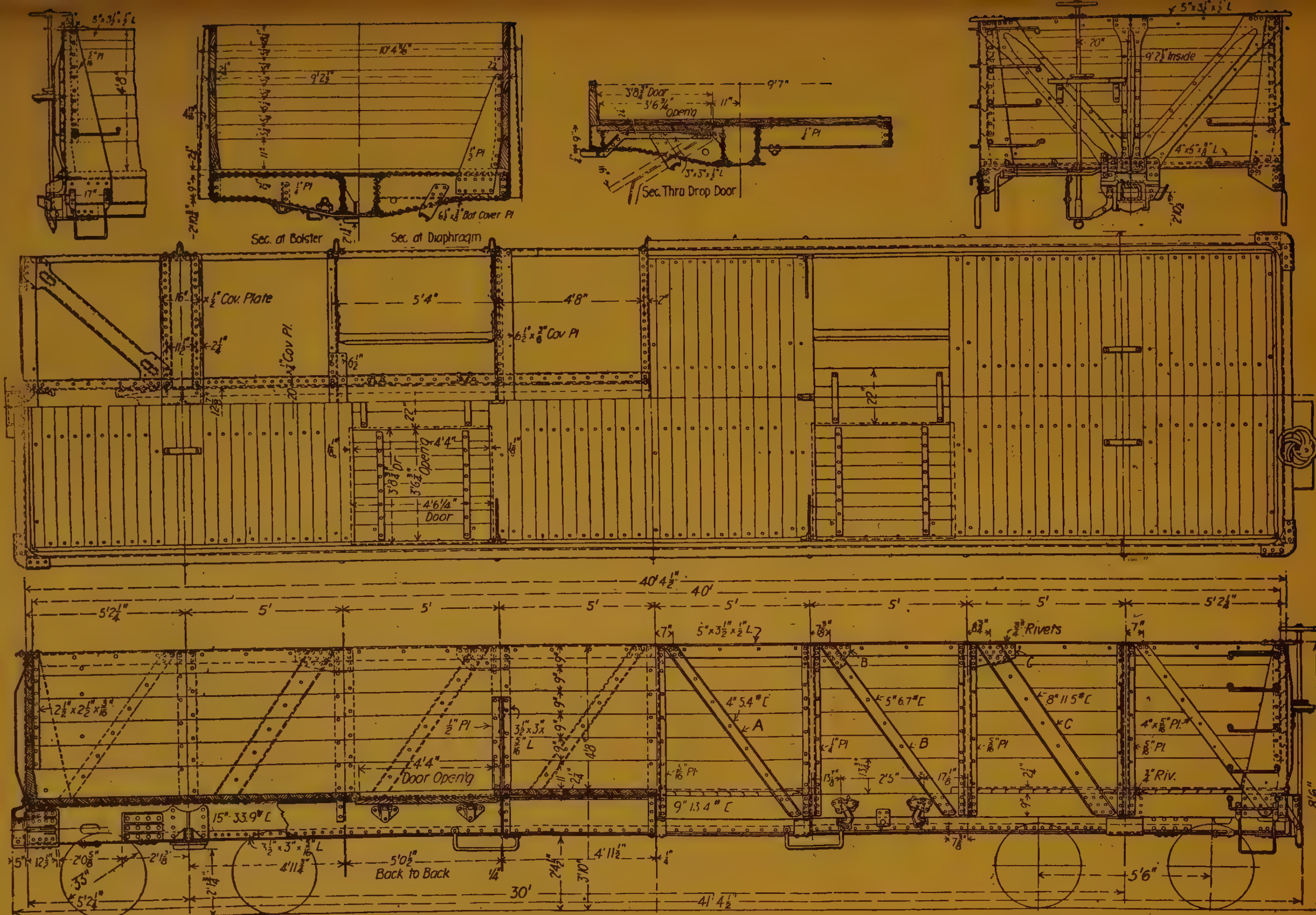


Fig. 1. — New 50-ton capacity composite gondola car for the Chicago, Milwaukee & St. Paul Railway. Elevation and sectional views.

end sills are also connected on the inside by means of angles and on the outside by the corner posts.

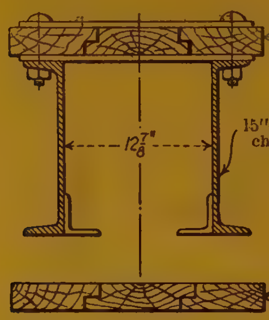


Fig. 2.— Section of center sill at drop door opening, illustrating method of securing longitudinal floor boards by means of traps and special board construction. The necessity of applying bolts between center sill channels is overcome.

The body bolsters are of built-up double diaphragm construction and each one is composed of four 1/4 inch pans or diaphragms spaced 8 inches back to back extending from center sill to side sill, one 14 by 1/2 inch bottom cover plate and one 16 by 1/2 inch top cover plate, continuous from side sill to side sill. The diaphragms have a depth equal to the combined depth of the center sill channels and the top cover plate at the inner end, the top flange being level while the lower flange tapers upwards toward the outside of the car and fits into the contour of the side sill channel. The bolster pans are connected to the body bolster top and bottom cover plates, center sill webs, side sills and body bolster stakes by means of 3/4 inch rivets passing through the flanges of the pans. The same rivets, four in number, which connect each bolster pan with the center sill channel web extend through the vertical side wall of the combined back stop and bolster separator casting. The body bolster top cover plate extends from side sill channel to side channel passing over the center sill top cover plate. The bolster bottom cover plate extends from side stake to side stake and in addition to being riveted to the bolster pans is also riveted to the inside bottom sill chord angles. The body bolster side bearings are pressed from 1/2 inch plate and are riveted to the body bolster bottom cover plate by rivets which extend through the bottom flanges of the bolster pans.

As the truss side frame is designed to carry all the vertical load not coming directly on the body bolsters three large crossbearers are used to transmit that portion of the load, coming on the center sills to the side sills. One of these crossbearers is located at the center of the car and one at a distance of five feet on either side of the center. The crossbearer pans are all pressed from 1/4 inch material, and are the same shape as those used in the body bolster construction. Each large crossbearer has a top and bottom cover plate of 6 1/2 by 3/8 inch material extending full width of car. The top cover plate construction is similar to that of the bolster cover plate in that it passes over the center sill cover plate. These cover plates are riveted to the flanges of the diaphragm pans and also to the flanges of the center sill and side sill channels.

Intermediate between the body bolsters and the first deep crossbearers are shallow cross bearers or ties, pressed from 1/4 inch plate with a uniform depth of 9 inches for their entire length, which extend from center sill girder to side sills. These cross ties are attached to the center girder by 6 1/2 by 3/8 inch top cover plates, approximately 38 inches long. Both the deep and shallow crossbearers are additionally secured, to the side sills by means of 3 1/2 by 2 1/4 by 1/4 inch angles.

Four diagonal braces, pressed from 10 by 1/4 inch plate are used to hold the underframe square when abrupt changes in speed occur and function when cars are polled in yards by transmitting the polling forces to the center sill. These braces extend from the corner of the car to the juncture of the adjacent center sill channel and bolster cover plate. At the corner of the car these braces are riveted to the side sill channels and the end sill angles, the inner ends being riveted to the bolster diaphragm and its top cover plate and also to the flange of the center sill and its top cover plate.

There are fourteen side stakes of U-section pressed from 1/4 inch and 5/16 inch plate, and stakes being open at the top and bottom. The second intermediate stakes are of 1/4 inch stock, the other ten being of 5/16 inch material. All the stakes are similar as regards width, height, taper, etc., the only difference being in the thickness of plate from which they were pressed and in location of holes for rivet and bolt connections. The stakes are riveted to the side top chord and the side sill channels and the first and second intermediate stakes are additionally secured to the top chord by 1/4 inch gusset plates. The stakes on the Railroad Administration Standard 50-ton composite gondola were 16 in number, an even number per side, resulting in an open or blind panel at the center. With an odd number as on the new Chicago Milwaukee & St. Paul car (seven per side) there is a stake located at the center of the car which was considered advisable by the designers. The panel length of 4 ft. 6 in. used on the administration car is some 6 inches less than the even 5 foot spacing on the present car. This longer panel spacing gives less slope to the diagonals which in this design was considered quite an advantage.

The side diagonal braces are not of uniform section; the brace for each panel has an area based on the total force or stress to be transmitted. Standard channels are used, three different sizes being necessary under this plan. The bolster braces are 8 inch 11 1/2 lb. channels, the intermediate braces 5 inch 6.7 lb. and the center braces 4 inch 5.4 lb. The bolster and intermediate braces are additionally secured to the top chord by means of 1/4 inch gusset plates. The side end straps are of 4 by 5/16 inch material.

As has previously been stated, the entire vertical load of the car except what comes directly on the body bolsters is considered as being carried by the truss members of the side frame. In transporting coal, cinders, sand, and such material there is, in addition to the vertical bending action, a lateral pressure on the car sides. This results in a bending action on the stakes, braces and top chords due to the entire side frames bulging. The stakes, braces and crossbeams under the floor tend to resist this lateral bending action. Centrifugal force, vibration resulting from motion and end forces due to shocks augment this static lateral pressure and make it difficult to maintain the car sides in vertical alignment.

The three large crossbearers in the present design not only serve as beams to transmit the vertical load from the center sill to the side sills and to stiffen the center sill against lateral buckling but also to act as stiffeners at the connections of the stakes to the side sills, in fact to give these posts more of the cantilever effect. The sides are additionally strengthened and stiffened by four 1/2 inch pressed shapes located 5 feet either side of the center of the car. Each pressing is riveted to a crossbearer and, by means of a 3 1/2 by 3 by 5/16 inch angle and the flange of the plate, bolted to the side boards and side stake.

The end reinforcement consists of a vertical stake at the center pressed from 1/4 inch plate secured to the end top chord and the end sill angle, and two 1/4-inch pressed diagonal braces extending from end sill angle at center to upper corners of the car. Each diagonal is riveted to the end sill angle at the bottom and to the top chord and corner post at the top. For the side and end top chord 5 by 3 1/2 by 1/2 inch angles with the long leg vertical are used. The side chords extend the full length of the car and are riveted to the side stakes, side braces and corner posts. Each top chord is riveted to the end center vertical post, end diagonal braces, corner posts and the end and side top chords are additionally secured by a 1/4 inch pressed connection. The angle shaped corner posts pressed from 5/16 inch plate are riveted to side sill channel, end sill bottom angle and to the side and end top chords.

The floor boards are 2 1/4-inches thick and 5 1/4-inches face, extending full width of the car except at the door openings where the floor boards run longitudinally with the car. These longitudinal boards are secured to the center sill top cover plate by means of straps and bolts. All the other floor boards except those directly over the bolsters are secured to center sill and side sills by means of bolts and 1 3/4

by 1/4-inch floor clips. The bottom side boards and the bottom end boards are 11 inches in height and taper from 3 3/4-inches at the bottom to 2 1/4-inches at the top. These boards with the exception of the bottom board at the door openings have a projection engaging the recess in the floor. The end bottom board and the side bottom board are mitered. The side boards, above the bottom board, are 9-inches face with the exception of the top board, which is 8 1/2-inches face. The end boards from the bottom board up with the exception of top end boards are 5 1/4-inches face, the end top board having a 7 3/4-inch face. All the floor and side boards are 2 1/4-inches except the tapered bottom and end boards. All boards are shiplapped except the longitudinal boards between the door openings. Here the construction was changed in the middle board in order that each outside board help hold the middle board in position. The sheathing is secured by 5/8-inch carriage bolts.

Each car is provided with four drop doors, two on each side, located between the first and second crossbearers. The width of the drop door opening is 3-ft. 6 3/4-in. and the length of the opening 4-ft. 4-in. The doors, like the remainder of the car flooring, are made of 2 1/4-inch thick select common fir, shiplapped and surfaced two sides. On the upper surface of each drop door are two 2 by 3/16-inch binding straps extending from back to front of door and spaced 2-ft. 5-in. center to center. Directly beneath each strap is a 3 by 3 by 1/2-inch door supporting angle. These angles are shaped so as to drop down under the side sill channel and when the door is in a closed position these angles extend out from the side of the car approximately 3 1/4-inches. The supporting angles are additionally stiffened by means of a « U » shape pressed pan extending from angle to angle at the front of the door and cut pressed gussets assist in securing a connection between the pan and the angles.

Hinge straps of 2 1/2 by 1/2-inch material, two per door, are riveted to the horizontal legs of the supporting angles at the ends adjacent to the center sill. By means of 5/8-inch carriage bolts passed down through the binding straps, the door boards and the supporting angles of the doors are bolted together. Two of these bolts extend through each hinge strap in addition to the three rivets which connect each hinge and angle. The doors being hinged along the center sill dump toward the side of the car and are operated singly. The door is slightly larger than the door opening overlapping 1 inch at the front and back and 1 1/8-inches on each end. The upper face of the doors is set flush with the under surface of the car floor proper and the doors are held in closed position by means of the Wine locking arrangement.

Drop door stops of 5 by 1/2-inch « U » shaped pressed plates are riveted to the webs of the small and large crossbearer diaphragm pans. The body center plates are drop forged, A. R. A. contour and are riveted to the body bolster and center sill members by rivets which pass through the bolster bottom cover plate and the flanges of the center sill channels and also by rivets passing through the bottom cover plate and the inside bottom chord angles.

General dimensions of the Chicago, Milwaukee & St. Paul Railway new 50-ton capacity composite gondola car.

Length, inside	40 feet.
Width, inside	9 ft. 2 1/2 in.
Height, inside	4 ft. 8 in.
Length over striking plates . .	41 ft. 4 1/2 in.
Width over all	10 ft. 3 5/8 in.
Height from rail to top of car body.	8 ft. 6 in.
Distance center to center of trucks	30 feet.
Height from rail to center of coupler.	2 ft. 10 1/2 in.
Height from rail to bottom of center sill	2 ft. 4 1/2 in.
Cubic capacity, level full . . .	1 730 cubic feet.
Weight	40 400 lb.
Limit load	129 000 lb.
Per cent, maximum revenue load to total weight	76.3 %.

[388 .581 (.44)]

2. — Revision of the conditions appertaining to the application of the 8 hour day on French Railways.

In the remarkable report that Mr. Mussat, general inspector of roads and bridges, has just presented to the « Conseil supérieur » of French railways concerning the rules relating to the public administration of the application of the 8 hour Act on the big railways, he has shown most clearly the unfortunate results which have happened to the railways in consequence of it.

This is how he first points out the characteristics of the present system : « The daily maximum of 8 hours is rigorously applied to all men in sedentary occupations. Except in rare cases no distinction whatever is made between time put in and effective work done. The daily eight hours must either be continuous or spread over two periods only, very exceptionally over three. They must be generally within a total period of 10 hours, rarely 12, very rarely 14 and in a few exceptional cases 15 hours ».

What influence, may be asked, has this arrangement had on efficient working ?

In 1913 the men employed on the six big railways amounted to 352 045; if this is compared with the number of train kilometres and the number of traffic units (which is the sum of kilometre journeys and kilometric tons) the result comes out at *0.88* workman per 1 000 train-kilometres (at 1.42 workman per 1 000 train-miles) and *0.79* workman per 100 000 traffic units.

In 1920, during which year the present system was put into operation, the number of workmen amounted to 493 263, equal to *1.86* individuals per 1 000 train-kilometres (2.99 individuals per 1 000 train-miles), and one individual per 100 000 traffic units. The efficiency therefore declined 112 % in respect to train-kilometres or 28 % when compared with traffic units.

In 1921 a longer trial of the 8 hour regulations made it possible to show a better result; the number of workmen came out at *1.62* per 1 000 train-kilometres (2.61 per 1 000 train-miles) and to *0.95* per 100 000 traffic units; in comparison with 1913 the efficiency has declined respectively 84 and 19 %.

The loss in real efficiency works out to a percentage lying between these two coefficients and is brought into evidence by the fact that in spite of the decrease in traffic from 1913 to 1921, the increase of employees on the big railways amounted to 110 800.

The writer showed by concrete examples the reduction of efficiency at stations. At the important station of Angers for instance, the staff was increased from 1913 to 1921 by 31 %, whilst the increase in the number of tickets sold only amounted to 4.6 %; on the other hand there was an actual decrease in traffic (13 % in the number of trains and 33 % in freight tonnage). At a station of small importance where running operations have sensibly declined and there has been little variation in the business done, the increase of staff amounted to 80 %.

The same thing was noticed as regards the employment of *pointsmen;* at an important centre on a big line, the number of pointsmen was increased by 75 % for an increase of 44 % in the number of trains dealt with; at a small box on the same railway two men are now employed for the operation of 14 trains, when in 1913 only one was sufficient for dealing with 16 trains.

Finally, on this same line the decrease in output as compared with 1913 in the *workshops and running sheds* is as follows :

25 % in the sum total of the large workshops;

23 to 27.5 % for the running sheds;

18 to 28.5 % for repairs;

32.5 % for the whole of the stores depôts.

Another example of decrease in efficiency is that of the Nord Railway station, the number of ticket windows having been increased by

30 % and the staff by 90 % for normal working (113.9 % in the Summer period), when the increase of traffic only amounted to 11 %.

From the financial point of view, the application of the 8 hours system has had a disastrous effect as far as railways are concerned; the increase in cost of the staff, not including drivers, firemen and train attendants, amounts to *676 millions;* the total deficit of the railways which amounted to 3 milliards in 1920 will exceed 1 200 millions in 1922. At the present time it is quite impossible to think of raising the rates; there is only one means to relieve the financial situation of the railways and that is in reducing the cost of the staff by means of an improvement in output.

This improvement may, according to Mr. Mussat, be obtained within the meaning of the Act of 23 April 1919, for as at present interpreted, which is the fruit of the commissions of 1919 appointed to put it into operation, it does not take full advantage of the facilities accorded by it as recently pointed out by Mr. Justin Godard, nor has use been made of its elasticity as explained by the President of the Republic in his speech at La Rochelle.

In order to improve the position of the companies, the Administration had prepared a decree which they proposed to introduce for the application of the 8 hour day on railways; the economy however which would result on the actual expenditure (about 115 millions) is too small an amount to be at all satisfactory. « It might be asked, adds the reporter, if it would not be preferable to stick to the provisional arrangement as at present constituted, rather than consolidate by means of regulations for public administration a situation which is the cause of such serious loss to the general interests of the Nation. »

More interesting to the mind of the writer are the proposals put forward by the companies themselves. The latter would distribute the working hours over the whole year and fixing at 2 504 (at the rate of 48 hours for 52 weeks and adding in one day) the number of working hours to be divided among the days of the year other than the 52 rest days and holidays. During seven years 300 hours would be added yearly to this number of 2 504 without supplementary remuneration.

This proposal of the companies would procure an economy of *426 millions.*

It is this project which inspired Mr. Mussat to suggest to the « Conseil supérieur » regulations for the application of the 8 hour day which received its approval.

The essential point in this new arrangement is the distribution of the working hours over the whole year, and according to the report, this arrangement would conform with the law. The latter in fact stipulates that the number of effective working hours must not exceed « either 8 hours per day, or 48 hours per week, *or an equivalent amount spread over a period other than that of the week* ». The law also authorises the distribution of the working hours over a number of days in which the 15 days holiday allowed by statute are not included since it provides in article 8 for « the distribution of the working hours in the 48 hour week so as to allow a rest on Saturday afternoon, *or any other equivalent period of time* ». It is in this sense that the « Conseil d'Etat » has interpreted the law, and in addition it is an interpretation that is in force in the municipal services of Lyons and has been suggested to the Municipal Council of Paris by Mr. de Fontenay.

In Mr. Mussat's counter proposal, the maximum for a day's work is fixed in principle at 10 hours (instead of the 12 hours previous to 1919) and as regard those whose duties may necessitate a greater length of time, this must not exceed 12 hours.

These exceptions will be classified either as of a temporary or permanent nature. Those of a temporary nature arise from work that is urgently required, the immediate execution of which is necessary for the prevention or repairing of a breakdown, organised measures for salvage, or in case of an abnormal increase of work during a period of heavy traffic. In the latter case the number of hours must not exceed 450 per year.

As in the scheme put forward by the railways, an increase of hours is provided for in the form of 300 hours without extra pay per

year, this being deducted from the 450 hours in exceptional cases mentioned above. This additional 300 hours cannot be considered, says the reporter, to be excessive. In fact this adjustment the institution of which conforms with the spirit of the Act should by definition bring about an intermediary state between that corresponding to the situation existing before the Act of 1919 and that created by the decree. Now, before the Act of 1919, the maximum number of working hours for an employee at the rate of 12 hours for 313 days amounted to 3 756. The proposed decree brings this maximum down to 2 504 or a difference of 1 252 hours, so that the increase above suggested does not amount to a quarter of this difference.

Switzerland, which, unlike France, has not had to face the trials of a war, has just permitted an extension in the weekly working hours which may amount to 54. This 54 hours allowance is equivalent to 2 817 annual hours, that is to say, that they exceed the 2 804 hours which results from the suggested increase of 300 hours.

M. PESCHAUD.

[385 .15 (498)]

3. — The reorganization of the Roumanian railways. (1).

Immediately after the war the Roumanian railways were confronted with serious difficulties which have not yet been completely overcome, and which have had the most unfortunate influence on the general condition of the country by causing an extreme shortage of transport at the very moment when good working of the railways would have contributed enormously to the economical recovery of Roumania.

The reasons for this shortage are many, but they all refer to the same source, which is the war followed by the political and economical disturbances it has caused in Eastern Europe.

Roumania, actually, came out of the war with the addition of territory which more than doubled its original area, but weakened by invasion the regions received as her share came to her in a condition of extreme disorganization. The railways were the first to suffer from this state of affairs: from 1 860 miles of track which Roumania possessed before the war the railway system increased to about 7 450 miles, but for this four-fold increase the number of locomotives available was only the same as that which the country possessed at the commencement of hostilities.

Moreover, more than half the railway system was in the hands of a non-Roumanian staff of men who were only slightly familiar with the working methods of the Roumanian Administration, and of whom some had only an extremely rudimentary knowledge of the Roumanian language. In Bessarabia, it was necessary to replace the Russian staff, which, even before the status of the railway had been definitely determined, had left the country, leaving the rolling stock and the tracks to look after themselves. These tracks, moreover, were not connected with the rest of the railway system as they had been built to the Russian gauge, whereas the other Roumanian lines are of normal gauge. This difference still exists.

Finally 150 railway bridges of all kinds, some of great size, required to be rebuilt in Bukovinia and in the old kingdom of Roumania, and the greater part of the shops for building and repairing the rolling stock, which had fallen into the hands of the Bolshevists, had had to be closed; the production of those shops that still continued to work was only insignificant.

Shortage of staff and of rolling stock, disorganization of the workshops of the services, want of uniformity in the gauge of the track and in the methods of working, and partial destruction of the lines : these were the con-

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(1) From the *Bulletin de la Société d'Etudes et d'Informations économiques* of 17 June 1922 (*Bulletin of the Society for Research and Investigation*).

ditions existing when the Roumanian Administration was called upon to resume the working of its railway system. The immediate result was an unprecedented shortage in transport, the effects of which are still felt at the present time, though to a smaller extent than in 1919, when they had taken such form that the railways were unable to guarantee the transport of the coal necessary for working the lines from one part of the country to another; thus the shortage of transport produced a shortage of fuel, which in its turn reacted on the former and prevented it recovering.

During the winter of 1919-1920 the average number of passenger trains was one train per day on ordinary lines and three trains per week on secondary branch lines. With regard to passenger traffic on narrow-gauge railways and to goods traffic over the whole of the railway system these were simply suspended and the interruption continued for several months.

At the present time the situation is much improved. Thanks to the firm stand that was made by the Government at the time of the great railway strike in the autumn of 1920, by putting the railway staff under military rule and introducing martial law and courts martial, a complete victory was obtained over the Bolshevistic tendencies shown by the staff, and this object was attained without the shedding of any blood whatever. Moreover, the institution of a bonus system and of various allowances to the staff completed this work of reorganization and brought the employees back to a sane frame of mind by eliminating the disturbing influence that is always caused by inadequate purchasing power of wages.

The results obtained, thanks to the combination of the two methods, were so satisfactory that, during 1921, it was possible to consider the resumption of ordinary working, to which, however, a return was only made gradually, the demobilisation of the staff being spread, as a precautionary measure, over a period of several months.

Once the question of the staff had been settled, the other, which was certainly equally great remained, that of the rolling stock and chiefly that of locomotives and wagons. The outlook was particularly dark in this respect, because Roumanian industry, which had been disorganized by the war, was not in the position to meet the immediate requirements of the railways.

The Roumanian Administration was therefore compelled to seek foreign help. From the commencement of 1920, orders were given to various firms in the United States, where the Baldwin locomotive works accepted an order for 50 *Consolidation*-type locomotives, which were paid for by the Roumanian Government in short-time bills based on the petroleum wealth of the country, and to be met on falling due by deliveries of mineral oil of equivalent value — an original method of payment which both parties were compelled to adopt because the Roumanian Government was not in a position to pay in the usual way.

Other orders were given to Germany, where the firm of Orenstein & Koppel received an order for locomotives to the extent of 90 000 000 marks at the commencement of 1921, and the firm of Henschel & Sohn of Cassel received another order for 40 G-8-2 locomotives about the same time; finally from Czecho-Slovakia and Austria; the latter, in particular, hired to Roumania, from the 30 April 1921, 100 locomotives and 2 000 goods wagons, payable by instalments, which the Roumanian Government had the option to purchase outright at any moment. Moreover, these various countries undertook to repair, in their own workshops, a portion of the Roumanian rolling stock, during the period required for setting Roumanian industry to work and enabling it to dispense with foreign assistance.

At the present time Roumania is beginning to reap the benefit of this initiative. The state workshops, enlarged and equipped with modern machine tools, are working faster and better; a large locomotive works erected by the « Reshita » Company, at present in course of construction, should commence working during next autumn. Moreover, there is a general improvement in the situation; the passenger traffic is gradually approximating to

that existing before the war, and the mean number of trains on the main line is from 2 to 4 fast trains per day. Each month a certain number of new trains, both express and slow, are put into service.

Unfortunatelly the goods traffic still leaves much to be desired : in the first place the stock of goods wagons was more difficult to replace than the passenger coaches, because it comprised a much larger number of vehicles, and it is in fact still inadequate. In addition it is not employed efficiently; it is not uncommon for there to be an excess of wagons at one point of the railway system and a shortage at another part. Again the staff is still wanting in practical knowledge and it is evident that time alone can remedy this state of affairs. Another disadvantage, which has already been mentioned above, still exists : it has not been found possible to change the gauge of the Bessarabian railway system to the normal 1 m. 44 (4 ft. 8 1/2 in.) gauge, and this break of gauge causes difficulty with the traffic: in fact all goods carried between Bessarabia and other parts of Roumania require to be trans-shipped.

Finally, the Roumanian railways suffer from the disadvantage that is common to the railway systems of all those countries which have been evolved from the division of the territories of the old Central Powers: although a large part of the Czecho-Slovakian railway system runs to Vienna and the other part to Budapest, the lines of the various territories that were annexed to Roumania in 1918 take very definite directions, the western lines towards the capital of Hungary, the north-western towards Prague and Odenberg and the north-eastern towards Odessa. Thanks to this arrangement communication with the exterior is ensured perfectly, but the same does not apply to the internal communication for the satisfactory arrangement of which several large junction stations are required. The only traffic centres of magnitude are Arad, Temesvar, and Bucharest, all three situated near the frontier, and it cannot be hoped that Bucarest will ever become the point of convergence of those Roumanian lines carrying heavy traffic as is the case, for example, with Paris or London; its position far from the centre of traffic would appear to prevent any hope of this.

Moreover, the first task which will have to be undertaken by the Administration of the Roumanian railways, once the rolling stock has been reconstructed and the railway system reduced to a uniform gauge, will be the improvement of the existing connexions between the railway systems in the various Roumanian provinces by means of new lines running in the direction of the main streams of exchange of traffic that run through Roumanian territory. The matter has already received attention and a certain number of the new lines that will have to be built in the future have actually been planned. These lines, with the addition of those which were in course of construction at the time that war was declared — and which had to be abandoned for the time, but will be recommenced at once — are the following:

Salonta Mare (Nagyszalonta) Chisineu (Kisje-nö). This line makes communication between the frontier regions of the north-west (the Russian Carpathians) as well as eastern Slovakia with the large commercial districts of the Banat of Temesvar. But as the town of Bekescsasba, which is the junction of the railways serving these various regions, is still in Hungarian territory, it is necessary to run 300 miles through Teins (Tövis) in Transylvannia, in travelling from Grossvardein to Arad, which are only 68 miles apart as the crow flies. The construction of a railway connecting these two points along the shortest route moreover has been commenced; the work was easy, the only two operations that presented any difficulty being the crossing of the white Körosz and the black Körosz. The engineers anticipate that the line will be in working order during May.

At the same time the change of gauge of the Grossvardein-Volea Lui Mihai (Ermihalyfalva) line was undertaken; this line, which had been reduced to the condition of a light railway of no importance during the time of the Hungarian rule, will play a leading part in the relations of Roumania with Czecho-Slovakia and its other western neighbours.

Thanks to this line, as well as to that previously mentioned, Roumania will have a large loop line running round the western frontier for almost the whole of its length, a line which by means of numerous branches into the bordering territory will become a valuable auxiliary for trading with Poland, Czecho-Slovakia, Hungary and Yugo-Slavia, thus relieving the Transylvanian system which is not capable of carrying heavy traffic on account of its steep gradients and sharp curves, due to the mountainous character of the country.

These are the only two lines on which any work has been done since the armistice. All the other lines named below only exist as schemes or had been partially constructed before 1914, work on them abandoned during the war, and not recommenced since.

These are:

1° The Bucharest-Rosiori-Caracal-Craiova line, which will shorten the run between Bucharest and Orsova, with the advantage over the existing line of running through flat country;

2° The Bucharest-Faurei-Tecuciu line, which will put Bucharest on the one hand and Bessarabia on the other in direct communication with the ports of the Danube and of the Black Sea and will, moreover, thanks to the cross-line at Tecuciu-Marasesti, double the important line from Czernowitz to Bucharest on the Marasesti-Bucharest system;

3° The Hamangia-Babadag-Tulcea line, which will bring northern Dobrudja and the delta of the Danube more closely into communication than at present with the large streams of railway traffic.

The lines that have been projected, but have not yet been commenced, are:

1° Caransebes-Resita: which will place the rich metallurgical basin of Oravitza Anina Steierdorf, of which Resita forms the centre, in direct communication with the interior of the country. At present exchange of traffic can only be carried out through Temesvar, which causes an unnecessary increase in the length of the journey. The proposed junction will probably not be completed without some difficulty owing to the mountainous character of the country;

2° Petrosani-Bumbesti: this line will give an outlet for the coal from the fields of Petrosani to the old kingdom of Roumania; this coal is the only coal of real industrial value in greater Roumania. The output estimated at 600 trucks per day before the war, has fallen at present to less than half this figure owing to difficulty of supply to the interior and if the congestion of traffic should continue it will be necessary to limit the output still further in order to avoid accumulating too large a stock on the spot. The future line will follow the narrow Sili gorge and will have a number of tunnels;

3° Cronstadt-Nehosiasi: this line is intended to replace the present line from Cronstadt to Predeal and Campina for the central Roumanian traffic to Galatz and the mouths of the Danube; the existing line traverses a mountainous country going over a pass over 3 280 feet above sea level and has every disadvantage — narrow tunnels, heavy gradients, sharp curves, etc. — tending to slow down the traffic. Moreover, as Predeal is the junction point of three important lines, it follows that the line from Cronstadt to Campina is in a chronic state of congestion; it is also thought that the proposed line which will be better constructed and have its summit at a height of 2 625 feet only, will afford considerable relief and will be the chief means of hastening the end of the shortage of transport;

4° Balti (Bielzy), Orhei (Orgjejen), Kichineff-Sachaidac. A glance at the map will show that Bessarabia at present requires a main line crossing it to make a junction between the Danube and southern Roumania; the proposed line will fill this want and at the same time it will end the isolation of the Orhei region, at present due to the absence of any line connected with the rest of the railway system;

5° Dornatrava-Ilva Mica (Kisilva). Just as there is no direct railway communication between Bessarabia and the Danube, so also northern Bessarabia and Bukovina are without direct communication; to get from Dornatrava to Ilva Mica about 44 miles apart it

is necessary to go through Ghimesch, Cronstadt, Predeal, Scatzburg and Bistritzan, a distance of more than 435 miles or ten times the distance between termini as the crow flies. This anomaly would be difficult to explain unless account were taken of the hostile feeling existing between Austria and Hungary before the war, which often led them to sacrifice the most urgent economical and strategic interests, as in this case;

6° Finally the Sighet-Baïa-Maro line, which will connect the Roumanian system with a line entirely dependent on the Czecho-Slovakian system, and the Constantza-Carmen Sylva (Tchirghio) line, constructed with a view to ensuring the development of the bathing resort of the district of Carmen Sylva, the construction of which should be completed during next summer.

In conclusion it should be noted that the schemes, set forth above, only form about one-fourth of the whole programme for extension of the railway system, which involves the construction of 1 243 miles of new track commenced during last year by the Minister of Transport. The Roumanian Government is taking an active interest, it will be seen, in equipping its country with a railway system which will seal its political unity and at the same time hasten its economic development. It might be feared that the means available for effecting this would prove unequal to the ambition of the Government, but the estimate of the Ministry of Transport figure in the 1922-1923 Budget at the amount of 3 milliards 187 631 000 lei, an increase of 927 millions of lei over the previous financial year. It will thus be seen that public works are given the first place in the general budget, and this speaks well for the effort which the public departments have decided to make in order to terminate the shortage of transport and to afford to Roumania the transportation facilities necessary for the full development of its industrial and agricultural resources.

M. PESCHAUD.

OFFICIAL INFORMATION

ISSUED BY THE

PERMANENT COMMISSION

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

Meeting of 15 July 1922 of the Permanent Commission.

The Permanent Commission of the International Railway Congress Association met on 15 July 1922 at the Railway Hotel, Brussels.

Present : Messrs. TONDELIER, president; BRUNEEL and COLSON, vice-presidents; BEHRENS and Sir Evelyn CECIL, members of the Committee; BARNET-LYON, BRAEM, CAUFRIEZ, DU CASTEL, FONTANEILLES, FOULON, FRANZA, Sir Guy GRANET, HANREZ, HEROLD, JAVARY, KEJR, MANGE, MARGOT, MEREUTZA, PHILIPPE, RIBOUD, TSANG OU, VANDER RIJDT, members; VERDEYEN, general secretary.

Messrs. HOLEMANS, secretary-treasurer; HABRAN, assistant secretary-treasurer; DESPRETS and MINSART, assistant secretaries, were present at the meeting. Letters were read from members unable to attend.

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I. — At the general meeting on the 27 April, the Rome Congress adopted the scheme of rules drawn up, in the name of the Permanent Commission, in Mr. VERDEYEN's report, with the following provisos :

1° That the alterations in the text proposed by the special section dealing with the different subjects be confirmed;

2° That article 17 (subscriptions) be replaced by article 18 in the scheme drawn up by the special section.

The Permanent Commission approved of the final text of the Statutes which were published in the September number of the monthly *Bulletin.*

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II. — At the final meeting of the Rome session, the assembly decided to hold the next Congress at Madrid in 1927. Several English delegates, however, expressed a wish for the meeting of the Congress to take place in London on the occasion of the centenary of the British railways, which will be celebrated in September 1925.

In view of the great advantages which the Association might gain by holding the meeting in England, the Permanent Commission asked if the Spanish Government would be opposed to postponing the Madrid meeting say until 1930. The latter is quite agreeable to this posponement.

There is therefore no reason why the

next session should not take place in London, either in September 1925, or in the Spring of 1926, and on the proposal of the Executive Committee, the Permanent Commission decided that the next session shall be held in London during the second half of the year 1925.

The English delegates have given assurance that the English companies will be pleased to make all the necessary arrangements for this meeting.

* * *

III. — At the general meeting of the 27 April last, the Congress instructed the Permanent Commission to nominate delegates from Poland, Egypt and Japan, a fourth delegate from the United States, a seventh English delegate and a second Spanish delegate.

The Governments of Poland, Egypt, Japan and the United States have not yet nominated their delegates.

Sir Francis Dent, South Easthern & Chatham Railway, was appointed to the vacancy open to Great Britain, and Senor Valenciano, assistant general director of Public Works to the *Ministro de Fomento*, to the vacancy open to Spain.

* * *

IV. — The balance sheet for the financial year 1921-1922 has been submitted, from the 22 June last, for examination by the members of the Permanent Commission.

This balance sheet has been audited and found correct; the Commission has approved of the same, together with the estimated expenditure for the period 15 April to 31 December 1922.

In drawing up this estimate, account has been taken of the decisions by the Rome Congress at the general meeting of the 27 April last.

Article 17 of these rules provides that the annual subscriptions of the adherent administrations shall consist of a fixed sum of 200 francs, and a variable sum not exceeding 50 centimes per kilometre.

This variable sum has been fixed at 35 centimes per kilometre.

* * *

V. — The following changes in membership have taken place since the last meeting:

A. — Governments.

The Finish Government has joined the Association.

B. — Administrations.

The following have joined the Association:

Finish State Railway	4 091 km.
Buffalo & Susquehanna Railway	407 —
Wabash Railway	3 980 —
Franco Ethiopian Railway Company (Djibouti to Addis-Abbeba)	783 —
Indo-China and Yunnan Railway	871 —

The following have ceased to belong to the Association:

Pau-Oloron-Mauléon Railway and Bayonne-Biarritz Tramways	10 km.
Anjou Light Railway	315 —

The Association consists at the present time (July 1922) of 268 administrations working lines amounting to 407 000 kilometres.

[385. (09.2]

OBITUARY

A. S. BALDWIN,

Vice-president of the Illinois Central Railroad;
Reporter to the Rome session (1922) of the International Railway Congress.

Mr. Archibald Stuart Baldwin, vice-president of the Illinois Central Railroad, died very suddenly on 26 June 1922, at the age of 61, of angina pectoris, on a Michigan Central Railroad train enroute from New York to Chicago. He was returning from a three-months' trip to Europe, during which time he made a study of railroads and railroad terminals preparatory to reconstruction and electrification of the Chicago Terminals.

He was descended from « The Elder John, » one of three Baldwin brothers who came to America from Berks County, England and settled in Milford, Connecticut 1632.

Mr. A. S. Baldwin was born in Winchester, Va., 28 September 1861. He was educated in private schools, Shenandoah Valley, Winchester, Va., and Staunton Military Academy. After teaching one year, he entered the railway service in 1879 as rodman on the Richmond & Allegheny Railroad, now part of the Chesapeake & Ohio Railroad. He was later, 1881 to 1883, assistant engineer of the Iron and Steel Works Association of Virginia, and engaged on railroad and blast furnace construction and development of ore mines.

In 1884 he re-entered the railway service as draftsman and assistant engineer on the Philadelphia extension of the Baltimore & Ohio Railroad, where he was in charge of construction of bulkheads and docks on the Schuylkill River. He left the service of the Baltimore & Ohio Railroad in 1885 to accept a position with the Chicago, Milwaukee & St. Paul Railway as principal assistant engineer, on the construction of its bridge across the Missouri River at Kansas City. Following this employment he was for a short time resident engineer on the construction of the St. Louis & Texas Railroad, now a part of the Louisville, Henderson & St. Louis Railroad.

He entered the service of the Louisville & Nashville Railroad in the Fall of 1887 as assistant engineer, during which time he aided in the development of the mineral district around Birmingham, Ala., was advanced to principal assistant engineer, in the office of the chief engineer, and later promoted to Roadmaster, leaving the service of that company in 1901.

On 1 September 1901 he came to the Illinois Central Railroad as principal assistant engineer; he was advanced to engineer of construction 1 May 1903 and promoted to chief engineer of the Illinois Central and Yazoo & Mississippi Valley Railroads 20 March 1905. As chief engineer he was in charge of both construction and maintenance.

Mr. Baldwin was in charge of the construction of a number of new lines; during his administration grades were reduced in a number of places.

Several pieces of second main track were constructed, several important pieces of bridge construction were completed.

Yards were built at several points, the most important of these being the new

Markham Yard now under construction just outside of Chicago, which will be among the largest in the world.

New and enlarged mechanical facilities were constructed at many points, and new passenger stations were built at Louisville, Ky. and Memplis, Tenn.

Track elevation in Chicago, begun north of 53rd Street prior to the Worlds Fair, was carried forward, and tracks were elevated from 63rd Street to 83rd Street, and from Burnside, Ill. to Kensington, Ill.

The signalling of the system made great progress, and 816.9 miles of single track and 631.5 miles of double track were signalled.

He held the position of chief engineer until 1 August 1918, when, at the beginning of federal control, he was elected vice-president of the corporation, and filled this office until the conclusion of federal control, 1 March 1920, at which time he was elected vice-president in charge of the Chicago Terminal Improvement.

Negotiations were begun in 1912 between the City of Chicago, the South Park Commissioners and the Illinois Central for the improvement of the Lake Front. Mr. Baldwin handled the entire matter from the time of its inception to the time of his death.

Mr. Baldwin left Chicago 29 March last to attend the ninth session of the International Railway Congress at Rome, and to which he was a « Reporter », having prepared a paper on the question IX « Terminal stations for passengers », for English-speaking countries. He took a very active interest in the Congress, and after its adjournment, made a trip through Italy, Switzerland, France and England, during which time he made a thorough study of railway terminals and heavy traction electrifications preparatory to the electrification of the Illinois Central Railroad terminals at Chicago.

The lamented Mr. Baldwin was elected a member of the General Committee of the American Railway Association and was member of numerous societies of American Engineers.

He was made an honorary member of the Tau Betta Pi, Alpha of Illinois, University of Illinois, 12 April 1918. He was also a member of the Franklin Institute and of the Chicago Engineers' Club and the Flossmoor Country Club.

He was highly respected and honored and made a reputation for himself as an engineer and an honest, conscientious man.

His kindly advice, straightforward reasoning and pleasing personality made for him a large number of friends, all of whom held him in the highest esteam, and with whom he was fond of swapping stories and telling anecdotes of his early life.

He never allowed his personal friendship to interfere in any way with his business dealings; and after heated arguments with his friends over business matters, immediately the subject was disposed of, resumed the most cordial relations with them.

He was untiring in his work, and the thoroughness with which he went into a subject was remarkable. He was loyal to his assistants and did not hesitate to compliment a subordinate who did his work well.

He was a great lover of nature.

Mr. Baldwin was a man of vast learning, and, yet, with a heart as simple as a child.

The funeral was held at Chicago, Ill., 29 June 1922 and interment was at Staunton, Va., 30 June 1922.

We present to his widow and children, as well as to his family our most sincere condolences and our compliments of true sympathy.

The Executive Committee.

A. W. GIBBS,

Chief mechanical engineer of the Pennsylvania System;

Reporter to the session of Washington (1905) of the International Railway Congress.

We have learned with the keenest regret of the death of Mr. Alfred Wolcott Gibbs, who passed away on 19 May last, at Wayne (Pa.).

Mr. Gibbs was reporter on question VII « Automatic couplings » at the session of Washington in 1905.

He was born at Fort Filmore, New Mexico, October 27, 1856.

He was educated at Rutgers College Grammar School, Rutgers College, and Stevens Institute of Technology, graduating from the latter Institution as Mechanical Engineer, in 1878.

He entered the service of The Pennsylvania Railroad Company as a special apprentice in March, 1879. In 1881 he went to the Richmond & Danville Railroad as draftsman; was master mechanic of different divisions of that road, 1886-1890; superintendent of motive power of Central Railway of Georgia from 1890 to 1892.

Mr. Gibbs re-entered the service of The Pennsylvania Railroad Company in 1893 as assistant mechanical engineer; was appointed superintendent of motive power of the Philadelphia, Wilmington and Baltimore Railroad Division in 1902; general superintendent of motive power, Pennsylvania Railroad, in 1903; chief mechanical engineer in 1911; and under the re-organization in March 1920, chief mechanical engineer of the entire Pennsylvania System, which position he held at the time of his death.

Among the organizations of which Mr. Gibbs was a member were the mechanical division of the American Railway Association; American Society of Mechanical Engineers; American Society for Testing Materials (President, 1915); American Engineering Standards Committee; American Railway Engineering Association; American Society of Naval Engineers; President of Eastern Railroad Association (dealing with patent matters) and member of the Board of Managers of the Franklin Institute.

Mr. Gibbs took an active part in the work of these organizations and was chairman or member of a number of their important committees.

We present to the widow and to the daughter of our regretted colleague our most sincere condolences and our compliments of true sympathy.

The Executive Committee.